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EVALUATION OF THE METHODS USED TO DETERMINE POTENTIAL HEALTH RISKS ASSOCIATED WITH ORGANIC COMTAMINANTS IN THE GREAT LAKES BASIN

by

Leonard M. Schuman, M.D., M.S., Professor
Conrad P. Straub, Ph.D., Professor Emeritus
Jack S. Mandel, Ph.D., M.P.H., Associate Professor
Stephan Norsted, M.P.H., Research Fellow
J. Michael Sprafka, M.S., Research Fellow
Division of Epidemiology
Division of Human Health and the Environment
School of Public Health
University of Minnesota, Minneapolis, MN 55455

EPA Grant 806282

EPA Project Officer
W. R. Swain
Large Lakes Research Station
Grosse Ile, MI 48138

ENVIRONMENTAL RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
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These results suggest that "lake-bordering" populations (i.e., white populations) experience higher rates of mortality due to stomach and esophageal cancers as compared to "non-lake bordering" counties. This trend is consistent when the potential confounding factor of large urban centers is removed.

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Polychlorinated Biphenyls in the Environment

I. Introduction

Polychlorinated biphenyls (PCBs) consist of a group of compounds produced by the complete or partial chlorination of a biphenyl molecule. These compounds belong to a family of chlorinated hydrocarbons in which chlorine has replaced hydrogen in the molecular structure (54). The stereochemistry of a PCB molecule is demonstrated in Figure 1. The molecule consists of two benzene rings joined at their apices with the potential for chlorine substitution on the remaining ten sites on the rings. The number of theoretically possible isomers is 209, but far fewer have been found in the environment (54). This may result from manufacturing processes producing specific molecular compositions eliminating the undesirable chlorinated species and/or environmental metabolism and degradation.

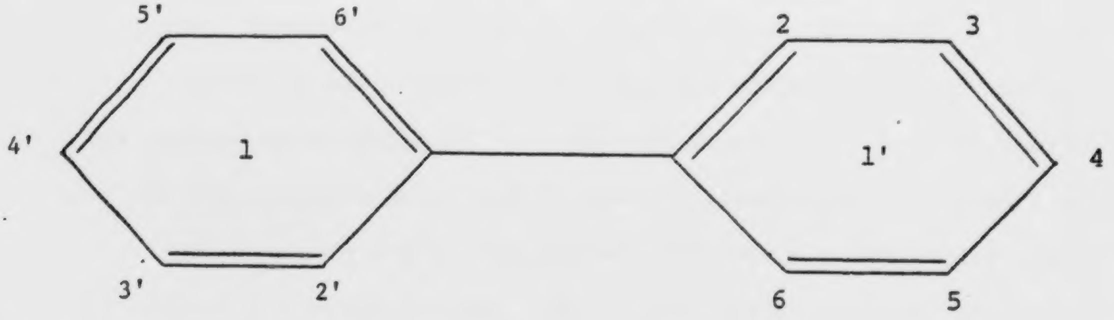
PCBs were discovered in 1881, but industrial applications and commercial production were discovered and undertaken in 1929 (50). The Monsanto company was the sole producer of PCBs in the United States and marketed its products under the trade name Aroclor. Other PCB producers are found in Germany, France, Italy, Japan, Russia, and Czechoslavakia and market their products under a variety of trade names (54).

Aroclor PCB mixtures are identified by a four digit number with the first two digits representing the type of molecule (12 = chlorinated biphenyl) and the latter two the average percentage of chlorine by weight in the mixture. For example, Aroclor 1248 represents a PCB mixture with approximately 48 percent chlorine by weight. Tables 1 and 2 depict the molecular composition of several Aroclor products. A comparison of the reported values for Aroclors 1242 and 1254 in Tables 1 and 2

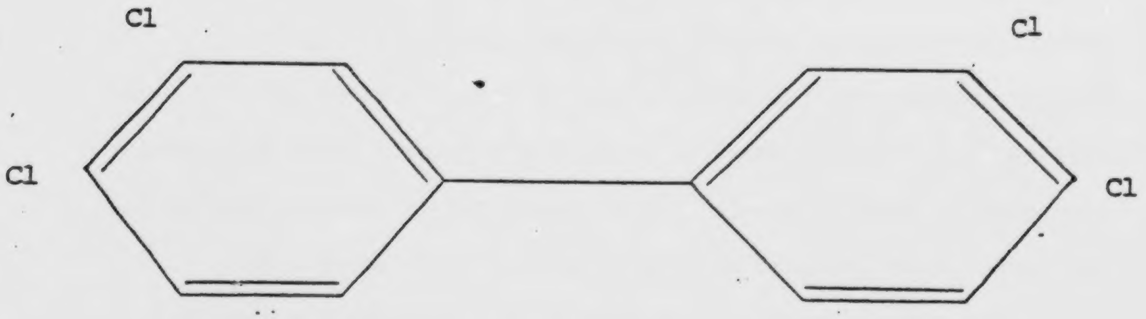
Figure 1

Sterochemistry of PCBs

Numbering system for the biphenyl molecule


5'
6'
2
3
4'
1
1'
4
3'
2'
6
5

example



3, 4, 4', 5' - tetrachlorobiphenyl

demonstrates variability in the percentages of chlorinated species. This may be attributable to differences in quantitative analysis and/or the products themselves. In addition, the variability in total and isomeric PCB percentages may be compounded when evaluating the analytical results of PCBs extracted from environmental matrices. In 1970, when these widespread industrial compounds were recognized as a potential problem, Monsanto restricted the domestic sales of Aroclors to uses in closed electrical and hydraulic systems which effectively cut in half the annual U.S. sales of PCBs. Veith reported data obtained from initial monitoring of PCBs in waters around the Green Bay, Wisconsin region indicating that PCB levels decreased sharply in 1971 suggesting that the self-imposed limitations on PCB production by Monsanto had immediate effects (112).

The production of PCBs by Monsanto stopped in August, 1977 and the sales of inventory stock ceased two months later. The complete ban on PCBs came into effect on July 1, 1979 with the enactment of the Toxic Substances Control Act (PL-94-46) (1). However, over the years, approximately 1.25 billion pounds of PCBs have been purchased by U.S. industries. Of that amount, it is estimated that 55 million pounds of PCBs have been destroyed by incineration or environmental degradation, 290 million pounds have been disposed in landfills and are assumed to have retained their toxic properties, and 150 million pounds are "free" in the environment (i.e., air, water, sediments, and animal tissues). The remaining 755 million pounds purchased by U.S. industries are currently in use (29). In addition, several foreign companies still produce PCBs without any restrictions on their use and U.S. companies are free to import these products. Estimates by the Environmental

Table 1

Molecular Composition of Some Aroclors

A. Chlorobiphenyl composition	% Aroclor product			
	1242	1248	1254	1260
$C_{12}H_9Cl$	3	-	-	-
$C_{12}H_8Cl_2$	13	2	-	-
$C_{12}H_7Cl_3$	28	18	-	-
$C_{12}H_6Cl_4$	30	40	11	-
$C_{12}H_5Cl_5$	22	36	49	12
$C_{12}H_4Cl_6$	4	4	34	38
$C_{12}H_3Cl_7$	-	-	6	41
$C_{12}H_2Cl_8$	-	-	-	8
$C_{12}HCl_9$	-	-	-	1

Hutzinger, O. et al. The Chemistry of PCBs. CRC Press, Cleveland (1974). p. 23

Table 2

Molecular Composition of Some Aroclors

B. Chlorobiphenyl composition	1221	1016	1242	1254
$C_{12}H_{10}$	11	<0.1	<0.1	<0.1
$C_{12}H_9Cl$	51	1	1	<0.1
$C_{12}H_8Cl_2$	32	20	16	0.5
$C_{12}H_7Cl_3$	4	57	49	1
$C_{12}H_6Cl_4$	2	21	25	21
$C_{12}H_5Cl_5$	<0.5	1	8	48
$C_{12}H_4Cl_6$	ND*	<0.1	1	23
$C_{12}H_3Cl_7$	ND	ND	<0.1	6
$C_{12}H_2Cl_8$	ND	ND	ND	ND

* ND - Not Detected (0.01%)

Hutzinger, O. et al. The Chemistry of PCBs. CRC Press, Cleveland (1974). p. 23.

Protection Agency indicate that the United States has been importing 500,000 pounds of PCBs per year as of 1976 and an unknown amount of PCB-containing products (1).

In order to evaluate the potential environmental effects of PCBs sampling surveys must produce quantitative information regarding PCB concentrations in various environmental strata (i.e., air, water, sediments, and food products). These data, characterizing PCB behavior in the environment, may help to predict transportation routes and identify high risk exposure groups in human populations. The purpose of this section is to review the physical and chemical characteristics of PCBs and the mechanisms regarding introduction and transport through the environment. In addition, a review of the potential health effects of PCBs on animal models and humans will be presented.

II. Physical and Chemical Characteristics of PCBs

The physical and chemical properties of PCB isomers and mixtures vary considerably when these materials are tested in the laboratory. Chlorine substitution markedly affects the three physicochemical characteristics important in the evaluation of the potential environmental impact and these include solubility, vaporization rates, and the capacity to biodegrade. The solubility and volatility of a particular PCB compound represent potential mechanisms for introduction into the environment and will determine the ease of distribution throughout ecosystems. Biodegradation represents a natural mechanism for the potential redistribution or removal of these materials from the environment.

The solubility of PCBs in water is low; however, reported values vary according to the isomeric structure, PCB type, and the composition of the aqueous test solutions. Dexter and Paulou analyzed several PCB isomers and found that their solubilities were five times greater when tested in sea water as compared to distilled water. This suggests that the potential for environmental contamination may be greater in ocean and estuary environments than fresh water environments (28).

In general it can be stated that as chlorine content increases, the solubility and volatility decreases. Table 3 depicts the differences associated with chlorine content, as evidenced by PCB type, and several physicochemical parameters (i.e., water solubility, vapor pressure, theoretical half-life) (29). These findings indicate that the association between increases in chlorine content and predicted decreases in solubility and volatility is not consistent with respect to Aroclor 1254. In addition, the values predicted for

Table 3

Physicochemical Characteristics for Several PCB Compounds

PCB Type	Solubility, mg/l	Vapor Pressure, mm Hg	Theoretical Half-life for Vaporization From 1 Meter $H_2$0 Column
1242	0.24	4.06×10^{-4}	5.96 hours
1248	5.4×10^{-2}	4.94×10^{-4}	58.3 minutes
1254	1.2×10^{-2}	7.71×10^{-4}	1.2 minutes
1260	2.7×10^{-2}	4.05×10^{-5}	28.8 minutes

Durfee, R. L. et al. PCBs In the United States Industrial Use and Environmental Distributions. Versar, Inc. EPA 560/6-76-005 (1976). p. 43.

the vaporization half-life of these Aroclors from a one meter column of water demonstrate inconsistency regarding PCB type (i.e., chlorine content). The solubility variations between individual PCB isomers are evident from data reported by Durfee in Table 4 . Increasing chlorine substitution decreases the water solubility. The vaporization rates of several Aroclors are shown in Table 5 demonstrating that as chlorine content increases the vaporization rate decreases.

In the environment, however, PCBs are subject to many influences which may alter standard laboratory classifications. As chlorine content increases in PCB molecules the solubility and volatility decrease while the sorption capacity increases (15). The particular matrix to which these molecules sorb will determine their availability in the environment. For example, the strength of adsorption in sediments and soils demonstrates a positive correlation with the concentrations of humic acid, ilite clay, and Del Monte sand in that order (95). In addition, Hague and his associates report that vapor losses from a sand surface are significantly greater than losses observed from an organic soil (43). Pierce and his associates concluded that suspended humic particulates may be an important transportation mechanism through the water column (96). Hence, similar PCB molecules sorbed to different environmental substrates may have different solubility and volatility characteristics and may move through the environment at different rates. Evaluation of these variables is essential in order to assess the potential environmental impact of PCBs.

The degradation of PCBs in the environment by two major routes has been described in the literature. These include microbial activity and photochemical reactions. The microbial degradation of PCBs involves

Table 4

Solubility of Chlorobiphenyls and Isomers in Water

Compound	Solubility mg/l
Monochlorobiphenyls	
2-	5.9
2-	3.5
4-	1.19
Dichlorobiphenyls	
2, 4 -	1.40
2, 2' -	1.50
2, 4' -	1.88
4, 4' -	0.08
Trichlorobiphenyls	
2, 4, 4' -	0.085
2', 3, 4	0.078
Tetrachlorobiphenyls	
2, 2', 5, 5' -	0.046
2, 2', 3, 3' -	0.034
2, 2', 3, 5' -	0.170
2, 2', 4, 4' -	0.068
2, 3', 4, 4' -	0.058
2, 3', 4', 5 -	0.041
3, 3', 4, 4' -	0.175
Pentachlorobiphenyls	
2, 2', 3, 4, 5' -	0.022
2, 2', 4, 5, 5' -	0.031
Hexachlorobiphenyl	
2, 2', 4, 4', 5, 5' -	0.0088
Octachlorobiphenyl	
2, 2', 3, 3', 4, 4', 5, 5' -	0.0070
Decachlorobiphenyl	
4, 4' - Dichlorobiphenyl	
+ Tween 80 0.1%	5.9
+ Tween 80 1%	>10.0
+ Humic acid extract	0.07

Durfee, R. L. et al. PCBs in the United States Industrial Use and Environmental Distributions. Versar, Inc. EPA 560/6-76-005 (1976) p. 47.

Table 5

Vaporization Rates of Several Aroclors

(Surface area: 12.28 cm^2)	Wt. Loss, g	Exposure at 100°C, hr.	Vaporization rate g/cm^2/hr
1221	0.5125	24	0.00174
1232	0.2572	24	0.000874
1242	0.0995	24	0.00038
1248	0.00448	24	0.000152
1254	0.0156	24	0.000053
1262	0.0039	24	0.000013
1260	0.0026	24	0.000009
1270 (Deca)	0.0015	24	0.000005

Durfee, R. L. et al. PCBs in the United States Industrial Use and Environmental Distribution. Versar, Inc. EPA 560/6-76-005 (1976) p. 45.

hydroxylation and oxidation reactions which convert aromatic compounds into ring-fission substrates (25). These reactions may follow different metabolic routes in aerobic environments as compared to anaerobic environments which may ultimately affect the rates of microbial degradation and the availability of these contaminants to higher organisms.

Rogoff reported that soil pseudomonads appear very active in the degradation of PCB compounds. He demonstrated that cleavage of the ring is preceded by hydroxylation necessary to provide two hydroxyl groups on the aromatic ring. These usually occur in the ortho position and the ring is cleaved across a bond adjacent to one of the carbon atoms which bears a group (102).

Furukawa and his associates studied the effects of chlorine substitution on the degradability of PCBs using species of Alcaligenes and Actinobacter. They concluded that degradation decreased as chlorine substitution increased. PCB isomers containing more than four chlorine atoms were less susceptible to degradation. Preferential ring fission of the PCB molecules occurred with non-chlorinated or lesser chlorinated rings. They also noted that positional variations in the isomers affected the rate of degradation. Those PCBs containing all the chlorine atoms on a single ring were generally degraded faster than when the same number of chlorine atoms were substituted on both rings (37).

Ahmend and Focht report data which indicate that some species of Achromobacter are capable of oxidizing PCB isomers with two to five chlorine atoms. However, the bacteria are unable to dehalogenate any of these chlorinated biphenyls as noted by the absence of chloride in all the supernatants. They conclude that increasing the chlorine substitution renders the biphenyl molecule more resistant to microbial attack

(3). In subsequent studies by these investigators they succeeded in isolating two species of Achromobacter from sewage effluent using biphenyl and p-chlorobiphenyl as sole carbon sources (2).

Sayler and his associates report that both PCB-degrading bacteria and PCBs were found in higher concentrations in estuarine waters and sediments compared with marine samples. Their data indicated a greater correlation between PCB concentrations and numbers of PCB-degrading bacteria in areas of urbanization as opposed to areas distant from land. Their results suggest that the assessment of existing PCB-degrading bacteria in environmental samples may be used as indicators for potential PCB contamination. They caution, however, that the number of PCB-degrading microorganisms in a given sample cannot be directly correlated with the concentration of PCBs in that sample (106).

It may be assumed from these studies that certain microbial species have the capacity to degrade these complex molecules but, in the natural environment, will preferentially attack simpler energy forms. If situations occur in the environment where simple carbon sources are exhausted, microbial species could, theoretically, develop pathways to metabolize more complex molecules like PCBs. However, the extent of microbial PCB degradation by natural microbial populations remains undetermined.

Photodecomposition is considered to be another potential mechanism for PCB degradation because of its similarities with chlorinated hydrocarbon pesticides (i.e., DDT) and the mechanisms associated with their degradation (104). However, Durfee et al., conclude that the probability of UV disassociation of chlorobiphenyls appears significantly less than for the chlorinated pesticides (29).

Hutzinger and his associates investigated the photochemical behavior of 2, 2', 4, 4', 6, 6' hexachlorobiphenyl in organic solvents. Results indicate a loss of chlorine, rearrangement, condensation, and the formation of new compounds. They caution that photochemical production of new compounds may lead to further complications in residue analyses with the possible appearance of chlorobiphenyls in environmental samples that are not found in commercial samples. Additional studies by Hutzinger et al., indicated that higher chlorinated biphenyls appear to degrade faster than those with lower chlorine content when exposed to a radiation source (53,54).

These results may have limited applicability to an environmental situation since these experiments were conducted in organic solvent systems (i.e., hexane) rather than water. Additional experimental strategies such as irradiation of chlorobiphenyls in the gas and solid phases as well as the relationship of positional isomerism and photochemical activity must be examined as potential mechanisms of PCB degradation in the environment.

The environmental behavior of PCBs is also influenced by their solubility in lipids and fats resulting in a tendency to bioaccumulate in organisms progressively higher in the food chain (118). As a consequence PCB routes through the environment may be subject to specific metabolic mechanisms which, in turn, are subject to the solubility differences of PCBs in the lipids of these organisms (88).

Biological concentration is a process whereby an organism demonstrates a greater concentration of a particular chemical factor as compared to the surrounding substrate or various food sources. This phenomenon is influenced by such factors as the amounts of chemical present in the diet or surrounding environment, the chemical and physical forms of the contaminant, the feeding and behavior traits of the animal species in question, the degree of assimilation through cellular barriers, and the extent of retention in the tissue (41).

Nisbet and Sarofim report that the more highly chlorinated isomers of PCBs are retained more efficiently; probably the result of metabolism and differential excretion (88). Their preliminary conclusions were that the more highly chlorinated isomers are not significantly differentiated as they pass through the food chain up to fish and birds. They concluded that differential metabolism is the primary mechanism in the environmental differentiation of isomers. Risebrough and his associates believe that current data suggest that the amounts and kinds of lipids may affect the capacity for retention of PCBs, modifying trophic accumulation predicted by the classical food chain concentration theory (100).

Several strategies have been proposed to study the bioconcentration phenomenon and these include self-containing ecosystems, dynamic circulating systems, and an equilibrium-type ecosystem. Self-containing ecosystems are limited because of maintenance considerations and expense but offer a totally simulated but contained ecosystem. Dynamic circulating systems are those in which the contaminant is introduced into the system at a prescribed rate while equilibrium ecosystems are those in which the contaminant is present in the environment and the organisms are introduced into the system (95). However, any model used to evaluate bioconcentration mechanisms has to incorporate and adjust for variations in eating habits, lipid content, age, sex, and size, all of which affect PCB levels in higher organisms.

III. Sources and Translocation of PCBs in the Environment

Environmental contamination with PCBs may be the result of both point and non-point sources. Point sources include vaporization or leaking from transistors and capacitors, municipal- and industrial-effluent discharges, leachates from landfills and dumps, and the incineration practices of manufacturers and municipalities. Non-point sources include land application of municipal sludges and chemicals followed by runoff, and the atmosphere (85).

Recent evidence suggests that a major source of PCBs may be the degassing of sanitary landfills and industrial dumps. Investigators have determined a difference of three orders of magnitude between ambient air and vent gas PCB concentrations (46). Gaffney demonstrated that chlorobiphenyls can be produced in the effluents of municipal wastewater treatment plants which practice chlorination and receive industrial wastes containing biphenyls (i.e., textile industries) (38). The experimental technique, however, was one of "super-chlorination" so the results may not be applicable to municipalities conducting normal treatment operations. Lawrence and Tosine report that localized areas of heavy industry may be responsible for trace organic contaminants in sewerage systems. These contaminants become associated with the suspended solid content of the sewage and are incorporated in the sludges following primary and secondary treatment (75). Land application of these sludges may increase the potential for environmental contamination following runoff.

Maugh has investigated natural sources of chlorobiphenyls and hypothesizes that a common metabolite of plants and animals, dichlorobenzophenone, may be degraded to a dichlorobiphenyl compound by photolysis (81). However, reaction rates are very slow and the exact chemical pathways are as yet undetermined. In addition, most PCBs in the environment have been identified as penta- and hexachlorobiphenyls which suggests that PCBs come from artificial (anthropogenic) rather than natural sources (88). Figure 2 demonstrates the potential mechanisms by which PCBs are introduced and transported throughout various ecosystems.

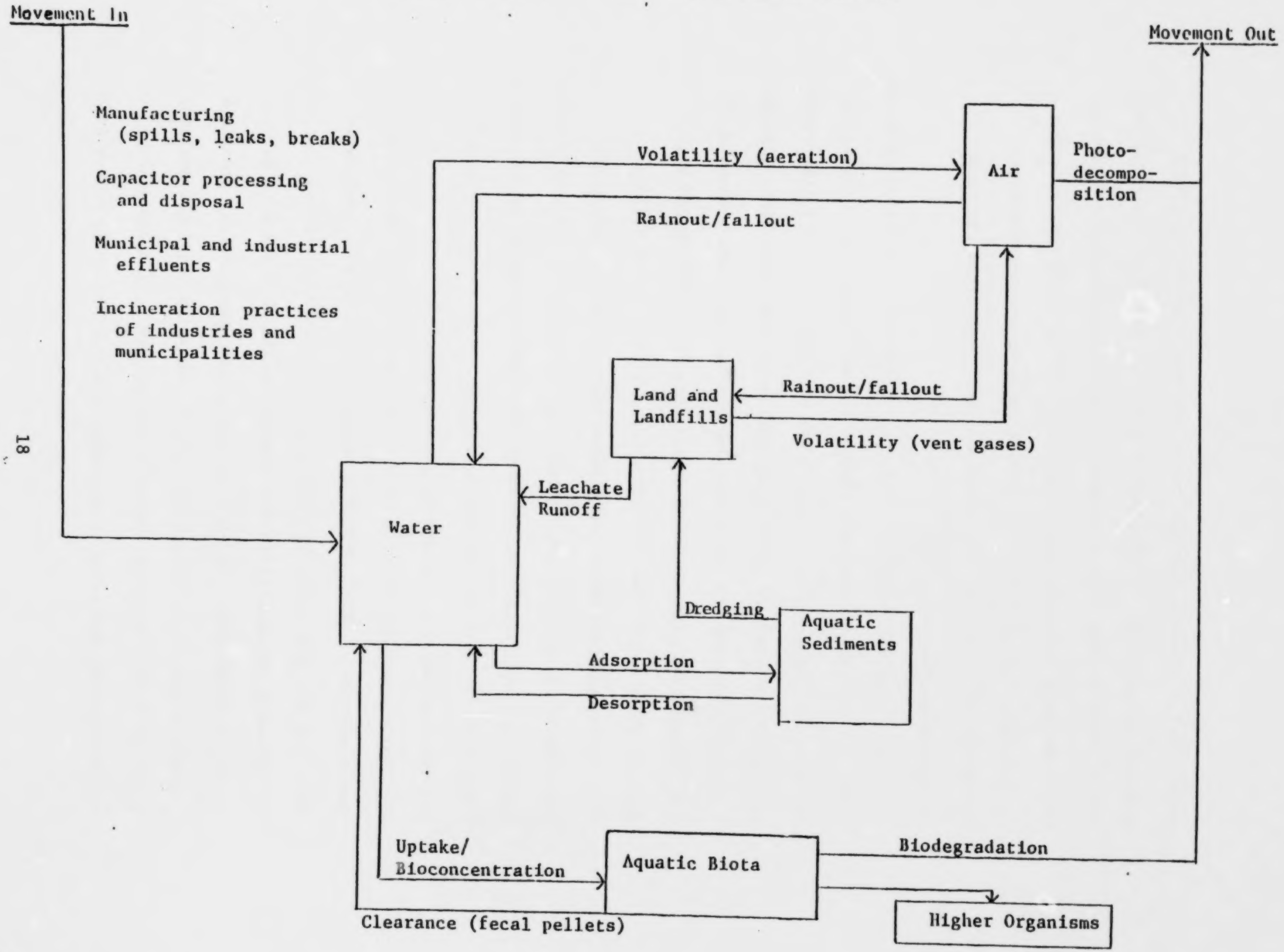
It is generally accepted that the atmosphere is the major route of entry and subsequent transport through the environment as evidenced by its ubiquitousness (88). Once in the atmosphere PCBs are distributed between the gaseous and particulate phases and are transported throughout the environment via the prevailing air masses. Most authors agree that atmospheric transportation occurs more frequently in the vapor-aerosol state rather than the particulate state (16,45,46,85).

Harvey and Steinhauer hypothesize that during the atmospheric lifetime of chlorinated hydrocarbons the vapor-aerosol and particulate states will equilibrate and exchange many times depending on the conditions (45). Both dry and wet deposition are potential mechanisms for loading into aquatic and terrestial ecosystems.

Water transport is considered to be more localized because of the low solubility of PCBs. PCB discharges into the aqueous environment will, for the most part, be associated with particulate matter and will settle out as sludges or become adsorbed to the bottom muds. However, uptake by zooplankton and fish and subsequent excretion may provide a transportation route through the aquatic ecosystem via fecal pellets. Elder and Fowler proposed that PCBs are carried to the sediment by rapidly sinking particles (i.e., fecal pellets) and these make a sig-

Figure 2

SIMULATED MOVEMENT OF PCBs THROUGH THE ENVIRONMENT


Movement In
Manufacturing (spills, leaks, breaks)
Capacitor processing and disposal
Municipal and industrial effluents
Incineration practices of industries and municipalities
Volatility (aeration)
Rainout/fallout
Air
Photo-decomposition
Movement Out
Land and Landfills
Rainout/fallout
Volatility (vent gases)
Water
Leachate
Runoff
Dredging
Aquatic Sediments
Adsorption
Desorption
Uptake/Bioconcentration
Aquatic Biota
Biodegradation
Clearance (fecal pellets)
Higher Organisms

nificant contribution to the vertical transport of these substances in aquatic environments. They reported data demonstrating PCB concentrations in feces (dry weight) ranging from 3.5 to 21 times higher than that in organisms which formed the feces (31).

In conjunction with the fecal transport hypothesis consideration must be given to the metabolic actions by aquatic organisms (i.e., fish) on PCB contaminants. Metabolic functions followed by excretion may alter PCB structure which, in turn, may influence the toxicity or availability of these materials to other organisms in the aquatic ecosystems. In addition, these metabolized products may alter PCB structure complicating quantitation.

Health Effects of PCBs

I. Animal Models

Several excellent reports have been written which review the health effects of PCBs in experimental animal models. These include the IARC Monograph on the Evaluation of the Carcinogenic Risk of Chemicals to Humans (55), The Health Effects of PCBs with Particular Emphasis on Human High Risk Groups (21), and the Final Report of the Subcommittee on the Health Effects of Polychlorinated Biphenyls and Polybrominated Biphenyls (33). These reports are briefly summarized in Tables 6-8 respectively.

In general, the principal organs affected by long-term exposure to commercial mixtures of PCBs in animals are the gastro-intestinal tract, the liver, and the lymphatic system (21). Reported pathological effects include carcinogenic and tumorigenic potential, immunosuppression, embryotoxicity, and reproductive dysfunctions (see Tables 6-8). In addition, PCBs have several sublethal effects such as microsomal enzyme induction, clastogenic activity, and modified cell development.

Thompson *et al*. conclude that Aroclor 1254 is a wide spectrum inducer of mutagenic activity based on their studies involving the effects of PCBs on rat-liver homogenate (59 preparations). In addition, they reported that the hydroxylations of the number 2 and 4 chlorines proceed via the arene oxide intermediate pathway which has been implicated in carcinogenesis and mutagenesis (111).

Hargraves and Allen investigated the *in vitro* binding of tetrachlorobiphenyl (TCB) to rat liver microsomes and reported a protein(s) in the induced system capable of binding a TCB metabolite. They conclude that their results support the concept of a metabolic activation

TABLE 6
Summary of the Health Effects of PCBs on Animal Models

1) Carcinogenesis

Mice:

hepatocellular carcinoma
hepatoma

Rats:

adenofibrosis of the liver
cholangiofibrosis
hepatocellular carcinoma
neoplastic liver nodule

2) Toxic Effects

Rats:

liver hypertrophy, marked fatty infiltration and degeneration of parenchymal cells

Chickens:

subcutaneous edema, ascites, hydropericardium
loss of fat
marked involution of the thymus
atrophy of the spleen
increased liver weight
congestion, mild necrosis and marked infiltrations of the liver
widespread hemorrhage and focal necrosis in the kidney

Rabbits (skin application):

weight loss
hyperkeratosis of the skin
liver-cell atrophy
kidney cell degeneration
atrophy of the thymus
lymphopenia

Rabbits (oral):

liver hypertrophy
atrophy of the uterus

Monkeys:

acne
swelling of upper eyelids
loss of eye lashes
alopecia
subcutaneous edema
gastritis
ulceration
hypoproteinemia
anemia

Table 6 (Continued)

3) Immune Effects

Guinea Pigs:

lymphopenia, thymic, and splenic atrophy
decrease in number of circulating lymphocytes

Rabbits:

lymphopenia, thymic, and splenic atrophy
decrease in number of circulating lymphocytes

Monkeys:

lymphopenia, thymic, and splenic atrophy
decrease in number of circulating lymphocytes

Duck:
increased hepatitis susceptibility

4) Endocrine Effects

Rats:

estrogenic effect

Nonhuman primates:

increased level of urinary ketosteroids
prolonged menstrual cycles with increased bleeding

5) Embryotoxicity, Teratogenicity, and Reproductive Effects

Rats:

increased mortality of the offspring
reduced mating performance
reduced litter size
decreased survival of the offspring
decreased maternal weight gain
decreased fetal weight
learning disability

Chickens:

reduced hatchability
abnormalities in the embryo

Rabbits:

fetotoxic abortions and stillbirths
increased maternal deaths

Table 6 (Continued)

Monkeys:

- facial acne and edema
- swelling of the eyelids
- loss of facial hair
- hyperpigmentation of the skin
- gastritis
- keritinization of the hair follicles
- early abortions
- small offspring

reference: IARC Monographs on the Evaluation of the Carcinogenic Risk of Cehmicals to Humans. Volume 18, (1978).

TABLE 7

Summary of the Health Effects of PCBs on Animal Models

a) Health Effects of PCB: Animal Studies

1. Effects on Liver and Spleen:

   weight increase, fatty degeneration, and necrosis of the liver in birds and a variety of mammals
   increased activities of some drug metabolizing enzymes
   reduced vitamin A storage in the liver
   altered lipid metabolism
   depletion of lymphatic nodules in the spleen in pheasants

2. Carcinogenesis and Tumorigenesis:

   hepatic adenofibrosis in rats
   biliary epithelial hyperplasia in rats
   induction of nodular hyperplasias in rats
   hepatocellular carcinomas in mice

3. Effects in Adrenal Gland:

   morphological alteration in the zona fasciculata of adrenal gland in rats
   increased levels of corticosterone in rats

4. Effects on the Reproductive System:

   decreased mating indices in rats
   number of young delivered, number surviving to weaning, both decreased
   increased number of stillborns
   decreased egg production in chickens
   decreased egg shell thickness
   decreased reproductive capacities in pheasants

5. Effects in Chromosomes:

   chromosomal aberrations in Ring Dove Embryos

6. Immunosuppression:

   reduction in lymphoid tissue, and the presence of amyloid or amyloid-like material in the liver of chicks
   lymphopenia in rabbits
   decreased number of antibody-forming cells after stimulation of lymphoid system in guinea pigs.

Reference: "The Health Effects of PCBs with Particular Emphasis on Human High Risk Groups," Edward J. Calabrese, Reviews on Environmental Health Vol. 2(4), 1978.

TABLE 8

Summary of the Health Effects of PCBs on Animal Models

Animal Toxicology

1) Reproduction depression:

   mink
   rhesus monkey
   rats

2) Hepatic porphyria:

   chicken
   rabbit
   Japanese quail
   rats

3) Liver damage and tumors including hepatocellular carcinoma:

   rat
   mouse
   primate

4) Bone marrow depression:

   primate

5) Gastric mucosa damage:

   rat
   dog
   primate

6) Atrophy of the thymus:

   rabbit

7) Fluid accumulation:

   chickens
   finches
   primates

Reference: Final Report of the Subcommittee on the Health Effects of Polychlorinated Biphenyls and Polybrominated Biphenyls, Dept. of HEW, Washington, D.C., July, 1976.

of microsomes resulting from PCB insult (44). Subsequent studies by Stadnicki et al. evaluated the potential clastogenic effects of TCB and its phenolic and arene oxide intermediates. They report that 2, 2', 5, 5', TCB-3-4 epoxide was more potent in causing DNA single-strand breaks than either 2, 2', 5, 5', TCB or a mixture of 3-hydroxy or 4-hydroxy-2, 2', 5, 5' TCB. They conclude that PCB epoxide intermediates may potentiate carcinogenesis (108).

Ohnishi and Noda evaluated the effects of Kanechlor 400 on dissociated conjunctival cells in vitro and reported an increase in the mitotic times of epithelial cells exposed to PCBs. Greater cellular damage was observed as PCB concentrations were increased. Ultrastructure changes of epithelial cells included an increase in the number of vacuoles, lysosome-like particles, myelin-like figures, and a dilute rough endoplasmic reticulum filled with secretion in the cytoplasm (89).

Hoopingarner and his associates investigated the effects of PCBs on Chinese hamster cells and primary human lymphocyte cells. In general, there was a steady drop in cell numbers as the percentage of chlorine in the PCB mixture decreased for both types of cells. They reported no apparent effects on chromosomal integrity as measured by cytological evidence (49).

In addition to the health effects of PCBs on experimental animal models, several investigators have evaluated the toxicity of PCBs on fish and other aquatic animals. A summary of these results appears in Table 9 . Of particular interest is the "bioconcentration factor" which has been reported by several researchers. Essentially, this "bioconcentration factor" is determined by measuring the contaminant concentration in water or food sources and the resulting contaminant

TABLE 9

Summarization of the Toxic Effects of PCBs on Aquatic Animals

Animal Model:
Fathead Minnow

Experimental Methodology:
Flow-through bioassays were conducted to determine both acute and chronic effects of the larvae and adults, as well as the bioconcentration of the mixture of PCBs in the fish.

Experimental Results and Conclusions:
30-day LC-50 for newly hatched larvae was 4.7 mg/l for Aroclor 1248
30-day LC-50 for newly hatched larvae was 3.3 mg/l for Aroclor 1260
reproduction occurred at or below 3 mg/l 1248 and at or below 2.1 mg/l 1260
bioconcentration factor in adult females at 25°C was approximately 1.2×10^5 for Aroclor 1248 and 2.7×10^5 for Aroclor 1260
females accumulated about twice as much as males
the chromatograms of 1248 and 1260 residue were essentially identical to the standard after a 200 day exposure. Subtle changes occurred in the first and second peaks (Defoe, 1978)

Animal Model:
Fathead Minnow

Experimental Methodology:
Continuous-flow bioassays were conducted to determine safe levels of Aroclor 1242, 1248, and 1254 for the fathead minnow

Experimental Results and Conclusions:
96-hour LC-50 for newly hatched larvae was 7.7 mg/l for Aroclor 1254
96-hour LC-50 for newly hatched larvae was 15.0 mg/l for Aroclor 1242
96-hour LC-50 for 3 month old fatheads was 300.0 mg/l for Aroclor 1242
reproduction occurred at or below 1.8 mg/l 1254 and at or below 5.4 mg/l 1242
males accumulated more 1254 and 1242 than females after a period of eight months (Nebeker *et.al*., 1974)

Animal Model:
Flagfish

Experimental Methodology:
continuous-flow bioassays were conducted to determine safe levels of Aroclor 1248 for the flagfish (*Jordanella floridae*)

Experimental Results and Conclusions:
no survival at or above 5.1 mg/l and did not grow well above 2.2 mg/l (Nebeker, 1974)

TABLE 9 (Continued)

Animal Model:
Daphnia

Experimental Methodology:
Continuous-flow and static bioassays were conducted at 18°C with survival and reproduction as measures of relative toxicity of Aroclors 1221, 1232, 1242, 1254, 1260, 1262, and 1268
Three PCB-mixture bioassays were also conducted

Experimental Results and Conclusions:
3 week LC-50 for *Daphnia* under static conditions was 25 mg/l for Aroclor 1248
3 week LC-50 for *Daphnia* under continuous-flow conditions was 1.3 mg/l for Aroclor 1254 (Nebeker and Puglisi, 1974)

Animal Model:
Gammarus

Experimental Methodology:
Continuous-flow and static bioassays were conducted at 18°C with survival and reproduction as measures of relative toxicity of Aroclors 1221, 1332, 1242, 1254, 1260, 1262, and 1268
Three PCB-mixture bioassays were also conducted

Experimental Results and Conclusions:
96-hour LC-50 for *Gammarus* under continuous-flow conditions was 73 mg/l for Aroclor 1242
96-hour LC-50 for *Gammarus* under continuous-flow conditions was 20 mg/l for Aroclor 1248
60-day survival percentage was 52% at 8.7 mg/l 1242 and 53% at 5.1 mg/l 1248 (Nebeker and Puglisi, 1974)

Animal Model:
Tanytarsus

Experimental Methodology:
Continuous-flow and static bioassays were conducted at 18°C with survival and reproduction as measures of relative toxicity of Aroclors 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268
Three PCB-mixture bioassays were also conducted

Experimental Results and Conclusions:
emergence did not occur above 5.1 mg/l 1248 or 3.5 mg/l 1254
3 week LC-50 for *Tanytarsus* larvae under continuous-flow conditions was 0.65 mg/l for Aroclor 1254
3 week LC-50 for *Tanytarsus* pupae under continuous-flow conditions was 0.45 mg/l for Aroclor 1254 (Nebeker and Puglisi, 1974)

TABLE 9 (Continued)

Animal Model:
Coho Salmon

Experimental Methodology:
Yearling coho salmon were fed PCB diets and mixed PCB-mirex diets to determine the effects on hepatosomatic indices, liver lipids, carcass lipids, and bioaccumulation

Experimental Results and Conclusions:
hepatosomatic indices were increased in salmon fed PCB diets and a mixed PCB-mirex diet and were decreased in salmon fed Mirex diets compared to controls
liver lipids in PCB-fed fish were significantly increased and carcass lipids significantly decreased
carcass PCB levels in Coho fed high PCB diet (500 mg/kg) were 3.2 fold higher than Coho fed the low PCB diet (50 mg/kg)
carcass PCB levels in Coho fed a mixed PCB-mirex diet were significantly higher than fish fed low PCB diet (Leatherland _et_._al_., 1979)

Animal Model:
Ciscoe

Experimental Methodology:
Continuous-flow bioassays were conducted to measure the acute toxicity of arsenic and PCBs, singly and in combination for ciscoe fry (_Coregonus_)

Experimental Results and Conclusions:
96-hour LC-50 for ciscoe fry was >10 mg/l for a mixture of 1248, 1254 and 1260
96-hour LC-50 for ciscoe fry was 3.5 mg/l for the PCB-arsenic mixture
the difference in PCB concentration between male and female _C.hoyi_ was highly significant (male ciscoe → 2.3 mg/g)
(female ciscoe→1.2 mg/g)
(Passino and Kramer, 1980)

Animal Model:
Brook Trout

Experimental Methodology:
Continuous-flow bioassays were conducted to determine the effects of 1 mg/l and lower concentrations of Aroclor 1254 on the life cycle of the brook trout

Experimental Results and Conclusions:
no adverse effects observed on survival and growth during 71 weeks of exposure or on their progeny exposed to 90 days of Aroclor 1254
body levels reached an apparent steady state bioconcentration factor 1×10^5
(Snarski and Puglisi, 1976)

concentration in fish tissues. The concentration of PCBs in the tissues of experimental fish models (i.e., fathead minnow, brook trout) is approximately 1.0 X 10^5 greater than that in the water (26). Jarvinen and his associates evaluated the bioconcentration factor of other chlorinated hydrocarbons (i.e., endrin, DDT) and reported similar results to those reported for PCBs (58). This suggests the potential for bioaccumulation in natural aquatic ecosystems given sources of PCB contamination. It is interesting to note the conclusions from a study by Weininger which indicate that direct uptake (i.e., from water to fish tissue) accounts for only 2 - 3% of the total PCB accumulation by adult lake trout in Lake Michigan. He suggests that food, primarily the alewife, is the major contributing source of PCB body burden in lake trout (115). In addition, he concludes that a large proportion ($>$50%) of the PCB burden in Lake Michigan lake trout has been cycled through the sediments suggesting that potential public health problems could persist for years. The human health implications of the behavior of PCBs in the aquatic environment, resulting from a demonstrated ability to bioaccumulate in fish, have not been adequately evaluated.

II. Human Exposures to PCBs and Other Organic Compounds

A. General

The results of surveys and experiments which have examined human exposures to selected organic chemicals are presented below. Polychlorinated biphenyls (PCBs) serve as the principal model for organic compounds throughout this review.

Information on the level of PCBs in the general population of the

United States has been released by the Human Monitoring Survey (HMS). Founded in 1967, the purpose of this organization has been to examine the exposure of the general population to pesticides. Residues from these compounds are measured in adipose tissue samples acquired from post-mortem examinations and therapeutic surgeries. Results from the HMS reported by Yobs in 1972 (117) state that 31.1% of 637 samples acquired contained one or more parts per million (ppm) of PCBs. In a comparison of gas chromatography with thin-layer chromatography by the HMS (98), both methods provided similar results indicating that 41-45% of the U.S. population have PCB levels of 1.0 ppm or more with isomers from Aroclors 1254, 1260, 1262, and 1268. A summary of "other" organochlorine residue levels for the years 1970-1974 inclusive are listed in Table 10 (74). The authors stated that residues of alpha-benzene hexachloride, lindane, and mirex were detected in adipose tissues infrequently ($\leq$ 2.05%). Residues of delta-BHC, aldrin, heptachlor, and endrin were not detected in the samples.

The following conclusions may be drawn from the HMS data:

a. Residues of various organochlorines are present in quantifiable amounts in the general population of the United States.

b. Between 30-50% of the general population have adipose tissues with $\geq$ 1.0 ppm PCBs. The most common isomers encountered are penta-, hexa, and heptachlorobiphenyl compounds (73).

c. HMS data for 1973 and 1974 indicated an increased percentage of tissues with trace levels of PCBs while the limit of detection (1.0 ppm) remained constant (73).

TABLE 10

Levels of Organochlorine Residues in Human Adipose Tissues

Compound	Survey Years	Average Sample Size	Average Percent of Samples With Detectable Residues	Average Geometric Mean in ppm.	Comments on Data Set Averaged
Beta-Benzene Hexachloride	1970-1974	1387	97.7	0.28	A trend was demonstrated toward a reduction in concentration over time but not in the frequency of occurrence
Total DDT Equivalent	1970-1974	1387	99.9	6.72	Same as Beta-Benzene Hexachloride
Dieldrin	1970-1974	1387	98.4	0.18	The geometric means and percent of samples which were positive were relatively consistent across the survey year
Heptachlor Epoxide	1970-1974	1387	95.0	0.086	Same as Dieldrin
Oxychlordane	1970-1974	1302	96.4	0.12	Same as Dieldrin

Source: Kutz et.al.(1977)

The sources of exposure to PCBs for the general population include foods, ambient air, ambient waters, contaminated soils, and occupational exposures.

B. Dietary Exposures

Estimates of PCB consumption from market-basket samples indicate an average adult ingestion of 5-10 μg per day (21). Variability in PCB consumption may result from special diets or accidental contamination of food products. Vegetarians may experience a lower exposure to PCBs as they limit fresh fish consumption. Accidental contaminations of human food stuffs are exemplified by the leakage of PCBs into "Shredded Wheat" from packaging materials (66), the introduction of contaminated poultry feed into Holly Farms livestock (66), and the "Yusho" (oil disease) incident (71).

The Yusho epidemic represents one of the largest case studies of acute toxic effects of PCBs in humans. The following description is a summary of the author's findings. In Fukuoka-ken, Japan a local rice oil-producing company developed a leak in a heat-exchanger. The oil was contaminated with 2,000-3,000 ppm Kanechlor 400 (48% chlorinated biphenyl). The average amount of PCBs ingested by subsequent patients has been estimated at 2 grams. The approximate minimum dose was 0.5 grams. The mean blood level among Yusho patients was 0.7 parts per billion (ppb). The predominant initial symptoms experienced by 136 of the Yusho patients were increased eye discharge, swelling of upper eyelids, acniform eruptions (chloracne), follicular accentuation, and increased skin pigmentation. Common, late-appearing symptoms included those noted above as well as weakness, sweating of palms, and brown pigmentation of the nails. Children born to patients and wives of patients had a high incidence of grayish, dark-brown skin, gingiva, and nails. Increased eye discharge, low birth weight, and infantile jaundice were also noted. Of the 13 pregnancies reported, two were stillborn. At a three-year follow-up half of the patients had clinically improved, over 10% had worsened, with the remaining patients demonstrating no change. The conclusion which may be drawn from the follow-up period is that clinical recovery is not common.

A summary of the clinical findings is presented in the reference by Kuratsune (70). His group found that severe "Yusho" patients experienced an increase in leucocytes, total lipids, triglycerides, serum lipoprotein β/α ratio, Cu, serum globulin α_2, and alkaline phosphatase. A decrease was found in red blood cells, hemoglobin, and Fe. The cases with characteristic "Yusho" acne had higher levels of cholesterol and stearic and oleic acids than those with normal acne. The pathological responses observed in the Yusho epidemic could be explained by the presence of chlorinated dibenzofurans in the rice oil. Chlorinated dibenzofurans are a contaminant of PCBs and are known to be highly toxic. Blood PCB levels as high as in Yusho patients but without adverse health effects have been reported in occupationally exposed workers (33). Therefore, conclusions cannot be drawn between the physiologic responses attributable to either of the two compounds.

Current foods which may provide high PCB exposure to the general population are fish and human breast milk (33). Results from the Food and Drug Administration (FDA) Total Diet Study (1971-1975) indicate that PCBs are no longer detected in food categories other than in meat-fish-poultry composites. The presence of PCBs in this category is attributed to fish. It is estimated that 93% of the U.S. population consumes fish. The average fish eater consumes 15 pounds of fish per year, which provides an approximate PCB consumption of 5-10 micrograms/day. The freshwater fish species most commonly consumed are trout, bass, catfish, and pike. A large fraction of fish consumed in the U.S. diet are unclassified breaded products (e.g., fish sticks). PCB measurements have typically not been initiated in this fraction (24). Further difficulties in describing PCB exposure via fish consumption are due to: (1) the inconsistent monitoring of PCB levels in fish; (2) most surveys having been based on small sample sizes; (3) PCB analyses usually being done on whole fish and not restricted to the edible portions; (4) fish being acquired for consumption without passing through commercial sectors where monitoring may be undertaken; (5) variations in PCB concentrations in individual fish by species, age, and geographical area.

A study by Humphrey (52) and others reported on the serum PCB levels of Lake Michigan sport fish eaters. The authors found these sport fishermen consume an average of 24-25 pounds of fish/person/year. A highly significant correlation was found between the amount of Lake Michigan fish consumed and blood PCB concentrations. Those fishermen who consumed less than 6 pounds/year had a mean blood value of 0.02 ppm. Those who ate more than one meal per week, or 24 pounds per year, had an average blood value of 0.073 ppm. This latter group had an estimated average intake of 1.7 μg/kg body weight/day of PCBs. The FDA recommends that PCB intake not exceed 1 μg/kg body weight/day. The authors found that blood PCB levels did not decrease significantly when fish consumption was eliminated for up to nine months, nor did the levels alter appreciably from year to year. A correlation between blood PCB levels and a pathological condition was not found in the high exposure group. The authors conclude that while Lake Michigan fish contribute to blood PCB levels in humans, the dose received has not produced a detectable health effect.

C. Exposure via Human Breast Milk

The other food, noted above, which may provide high exposure to PCBs is human breast milk. From 1974 to 1977 Kodama and Ota (65) studied blood PCB levels in volunteer women and their newborns at a hospital in Aichi Perfecture, Japan. The following samples were acquired by the authors: (1) maternal blood at 8 and 4 months prepartum; at delivery, and 1, 3, 5, and 7 months postpartum; (2) mother's milk at 1, 3, 5, and 7 months postpartum; (3) cord blood at delivery; (4) newborn infant blood at 3 months, 1 year, 2 years, and 3 years after birth. The results of the study indicate that maternal blood PCB levels increase with gestation and thereafter decrease to general population levels by 5 months postpartum. Maternal blood at delivery has a significantly higher PCB level than cord blood. When considering cord blood as newborn blood, PCB blood levels in breast-fed infants increased with ingestion of human milk. At 3 months postpartum the blood levels in the infants exceeded that of their mothers. The peak blood PCB level was reached at one year of age and decreased thereafter. Those infants who were bottle-fed had consistently low levels over the same time period. The authors conclude that the quantity of PCBs passed from mother to child is greater in lactation than through the placenta.

In the "National Study of Chlorinated Hydrocarbon Insecticide

Residues in Human Milk, U.S.A." (105) breast milk samples from 1436 women were obtained. The percent of samples positive for dieldrin, heptachlor, and oxychlordane by geographical region are presented in Table 11 . Eighty percent of all samples collected had detectable levels of dieldrin. Oxychlordane, a metabolite of chlordane, was detectable in 74% of the samples. Heptachlor was found in less than 2% of the samples, yet its metabolite heptachlor epoxide was found in 63% of the samples. The authors note that after adjusting for fat content in the samples, the mean residue levels for the three compounds in Table 11 were 164.2 ppb for dieldrin, 91.4 ppb for heptachlor epoxide, and 95.8 ppb for oxychlordane. It was quite common for a single subject to have relatively high values for more than one compound. The trend for higher mean values in the southeastern U.S. was attributed to more extensive use of home pesticides and termite control.

Studies which support the above findings of organic contamination of human breast milk were conducted in Michigan, Arkansas, and Mississippi. The Michigan study (116) was conducted in 1977 and 1978. Breast milk samples from 1,057 nursing mothers were analyzed for PCB residues. PCB levels ranged from trace amounts to 5.1 ppm, with all 1,057 samples positive (fat weight basis). The mean PCB level was 1.5 ppm. PCB levels of 1-2 ppm were found in 49.5% of the samples, 2-3 ppm in 17.4% of those sampled, and 6.14% of the women had greater than 3 ppm. Approximately one-half of the women had PCB levels equal to or greater than the present FDA tolerance limit for cow's milk. If an infant were breast-fed by a woman having the mean PCB level (1.5 ppm) in this sample, the child would have an estimated body burden of 0.89 ppm of PCBs. The infant's PCB body burden would increase steadily with the consumption

TABLE 11

Percent of U.S. Breast Milk Samples With Levels of Chlorinated Hydrocarbon Insecticides or Their Metabolites at ≥51 ppb by Geographical Region (N = 1,436)

Geographical Region

Compound	Northeast %	Southeast %	Midwest %	Southwest %	Northwest %	Total U.S. %
Dieldrin	55	84	74	76	69	73
Oxychlordane	54	72	57	54	52	58
Heptachlor Epoxide	43	56	57	25	24	42

Source: Savage et. al. (1981)

of breast milk for the entire period of breast-feeding. The authors stress that the women in this study may not be representative of all Michigan women as they were not randomly selected. They further state that the PCB levels found in several counties in the western part of the lower peninsula as well as in three counties of the upper peninsula exceeded 2 ppm. It is speculated that these levels may reflect a higher dietary intake of PCB-contaminated fish from the Great Lakes.

Fifty-seven women residing in Arkansas and Mississippi contributed whole milk samples for organochlorine pesticide residue analysis. The results from this survey are presented in Table 12 (74). The percent of samples positive range from 14.1 (trans-nonachlor) to 100.0 (total DDT equivalent; p, p'-DDT; p, p'-DDE). The arithmetic mean concentration in ppm ranged from 0.01 for many pesticides to 0.34 for total DDT equivalent. The discrepancy in values of the percentages positive between Tables 11 and 12 for the respective compounds may be due to differences in analytical techniques, sample size, properties of the geographical areas surveyed, and a multitude of demographic variables. Yet, both tables are consistent in the finding that significant proportions of the women surveyed have contaminated breast milk.

A study of Dutch mothers and their infants (30) provides evidence which challenges a number of the conclusions drawn above. Pregnant women were divided into four groups: (1) those not on a slimming diet who breast fed; (2) those not on a slimming diet who bottle-fed; (3) those on a slimming diet who breast fed; (4) those on a slimming diet who bottle-fed. Maternal blood samples were acquired as early in pregnancy as possible and, at parturition, from the umbilical cord and placenta. Post-natal blood samples at 10 days, 6 weeks , and 3 months

TABLE 12

Organochlorine Pesticide Residue Levels in Whole Milk Samples from Women Residing in Arkansas and Mississippi (n=57)

Pesticide	Percent of Samples Positive for Pesticide	Arithmetic Mean of Concentration in ppm.
Total DDT equivalent*	100.0	0.34
p, p' - DDT	100.0	0.09
p, p' - DDE	100.0	0.22
β - BHC	36.8	<0.01
Dieldrin	28.1	<0.01
Heptachlor expoxide	25.1	<0.01
Oxychlordane	45.6	<0.01
trans-nonachlor	14.1	<0.01

Source: Kutz et.al. (1977)

were acquired from the infant and mother. Milk samples were taken daily from breast-feeders. Data are not presented on organochlorine levels in human milk. The results of this study indicate that higher organochlorine concentrations are not found in the blood of breast than of bottle-fed infants. Further, there are no differences between the organochlorine concentrations in the blood of breast than of bottle feeding mothers. Between 12 and 21% of the daily intake of dieldrin by mothers was eliminated in their milk and ingested by the infants. The corresponding range for total DDT was 36 to 61%. The ranges were based upon the infants' consumption level during the first 3 months postpartum. It is interesting to note that the blood concentrations in slimming and non-slimming mothers were very similar except for those for dieldrin. As would be expected from the lipid solubility of organic compounds, dieldrin concentrations were higher in the slimming diet mothers.

Several investigators who have reviewed the health risks of organic compounds in human breast milk have concluded that no obvious pathology has resulted from breast feedings by the non-occupationally or acutely exposed mother (13, 101, 62). In an article on PCBs in human breast milk (82) the author states that unless a woman has a definite history of PCB exposure, she should be encouraged to breast-feed her infant. Kendrick (62) presents a more cautious appeal for the weighing of potential risks against known benefits in breast feeding.

D. Community Surveys

Testimony to the ubiquitous nature of organic compounds has been provided by their prevalence in the adipose tissue of the general population and human breast milk. Community based studies have been initiated to assess the general health effects of these pollutants. The residents of Triana, Alabama were studied in 1979 since they were known to consume fish contaminated with DDT and PCBs (69). Serum PCB levels were determined for 458 subjects. The geometric mean serum level was 17.2 μg/L. A positive association was found between PCB levels and age after controlling for sex, local fish consumption, obesity, serum cholesterol level, and alcohol consumption. PCB levels were also positively associated with gamma-glutamyl transpeptidase level, serum cholesterol level, and blood pressure. This latter positive association was independent of age, sex, body mass index, and social class. The rate for borderline and definite hypertension was 30% higher for the study group than would be expected from national rates for a demographically similar population. PCB exposure was associated with changes in liver function tests. Breast-fed children did not have significantly higher PCB levels than bottle-fed children, although, a positive trend was demonstrated between breast-feeding and DDT. The authors conclude that the association found between PCB levels and blood pressure, liver function, and cholesterol concentrations warrant further investigation since the PCB levels in this population overlap those found in other communities.

The effects posed by DDT exposure on the health of the Triana residents are discussed in a second paper (68). The national geometric mean total DDT level in serum was 1.5 ng/ml; the respective geometric mean for the 499 Triana residents was 76.2 ng/ml. The source of human exposure was contaminated local fish. From 1947 until 1971, a DDT plant 10 km from Triana deposited several thousand tons of DDT waste into a local tributary.

An average of 86.7% of the total DDT detected was of the metabolite

DDE. Acute health effects from DDT exposure were not found in the predominantly black (86.9%) study population. Positive associations with DDT levels were found with serum triglycerides, alcohol consumption, cigarette smoking, and liver enzyme induction. The authors state that their most striking finding is an increase in serum DDT levels with age without reaching a steady-state level. Age was the single most powerful predictor of DDT level (log transformation). The rate of increase in DDT levels in women did not change with hormonal status. The authors further emphasize that the increase in average serum DDT levels in the elderly suggest age-related changes in absorption, excretion, or storage between serum and adipose tissues.

In 1976, the sewage sludge used by Bloomington, Indiana residents for garden fertilizer was found to contain a mean PCB concentration of 479.1 ppm (84). The PCBs had been discharged into the city sewerage system by a local electrical manufacturing firm. To evaluate possible health effects from this exposure, three study groups were selected by the Monroe County Board of Health and the CDC: (1) occupationally exposed workers, (2) the workers' families, and (3) the residents who had utilized the sewage sludge in their garden. The mean serum PCB level was highest for the worders (71.7 ppb), second highest for the workers' families (33.6 ppb), third highest in community residents not utilizing sludge in their gardens (23.8 ppb), and lowest in those residents using the contaminated sludge (17.6 ppb). The sample sizes for each of these groups are 18, 19, 29, and 91 respectively. Correlations were not found between serum PCB levels and the number of years of contaminated sludge utilization, the total number of pounds used, or the length of the interval since last use. The authors did find that plasma triglyceride concentrations and serum gamma-glutamyl transpeptidase increased significantly with increases in serum PCB levels. These associations were found to be independent of age.

One of the most recent community studies evaluating the effects of numerous toxic wastes on human health was conducted in the Love Canal area (57). When cancer rates in the Love Canal residents were compared to data from the New York Cancer Registry, no evidence was found for an increased risk in the disposal area. A higher rate of respiratory cancer was noted, but appeared to be part of a high rate for the entire city of Niagara Falls. The authors acknowledge that the study design could not assess the influence of such confounding variables as socioeconomic status, smoking, air pollution, and population migration.

The community studies reviewed above have provided evidence that organic compounds have been found in residential areas. The source of the contamination has often been identified as industrial wastes. While PCB levels have been documented in human serum, the above studies have not demonstrated significant pathological responses. A paucity of studies have been performed on individuals occupationally exposed to PCBs. It is hypothesized that these groups experience a greater exposure potential than the general population, and would therefore more readily manifest any possible toxic effects. One of the earlier studies examined the level of PCB residues in the plasma and hair of refuse workers (42). Detectable plasma PCB levels were found in 81% (32/37) of the refuse burners and only 11% (6/54) of the control population. Scalp hair was found to have no value in estimating PCB body burdens. The increased plasma PCB levels in the refuse workers were hypothesized to be due to refuse incineration.

A subpopulation of Michigan residents were exposed to polybrominated biphenyls (PBBs) in 1973 by an accidental contamination of animal feed supplement (19). Several of the residents subsequently complained of memory loss. To test the hypothesis that PBB exposure may affect memory, twenty-five chemical workers who manufactured PBBs were given learning and memory tests. PBBs were found in adipose tissue samples of the workers, yet the mean scores on all memory tests were normal. The memory dysfunction of the Michigan residents was attributed to a psychological dysfunction and not to PBB body burden.

E. Occupational Studies

Workers who have been exposed to PCBs while manufacturing capacitors have shown the following health effects: (1) 14% of 243 employees demonstrated a reduced forced vital capacity. The mean number of years employed in this group was 15 (114), (2) for those who had been employed for more than 10 years, the most common symptoms reported involved dermatologic and CNS dysfunctions (34), (3) the latter group of workers had a functional capacity of the cytochrome P-450 system different from the non-exposed workers. Overall, the investigators were impressed by the paucity of abnormalities found in the physical examinations (34).

In an occupational retrospective cohort study of PCB-exposed workers, both the "all cause" and cancer mortality rates were lower than expected (18). The corresponding values were 163 observed total deaths versus 182.4 expected total deaths and 39 observed cancer deaths versus 43.8 expected cancer deaths. Elevated rectal and liver cancer mortalities were noted, but were not statistically significant. An increase in cirrhosis of the liver was found in one of the plants examined. Mortality due to rectal cancer and cirrhosis of the liver increased with an increase in latency, but these trends were difficult to evaluate due to the small number of reported deaths. The increase in liver cancer is noteworthy since it agrees with the findings of animal dietary models.

The two studies referenced below have examined the risk of hydrocarbon-exposed workers fathering children who subsequently develop malignancies. Positive results were found in a Quebec study of 386 children who died of malignancies prior to 5 years of age. A significant excess (relative odds of 2:1) of fathers were found to work in hydrocarbon-related occupations (32). Negative results were found in a review of the Finnish Cancer Registry (40).

The dermatologic lesions found in the Yusho incident have been reported in occupational groups . The dermal sores have been known to last for months after removal of the workers from the occupational exposure. Systemic effects including nausea, lassitude, anorexia, digestive disturbances, impotence, and hematuria have also been reported (21).

The occupational studies listed above have found workers to be exposed to various organic compounds and at risk of experiencing a wide range of symptoms. A number of methodologic problems may be found in these studies. A major problem in many occupational studies is adequate documentation of the amount of exposure to a given worker via inhalation, ingestion, and absorption. Secondly, many of the industries provide exposure to other compounds which may act in a synergistic, antagonistic, or additive manner to the chemical under study. The healthy-worker-effect and small sample size may have minimized adverse trends. In conclusion, the occupational studies performed to date do not allow a definitive statement as to the health risks of long-term low-level exposure to organic compounds.

F. Teratogenic Research

The unborn child is at risk of experiencing the toxic effects of organic compounds. Many organic chemicals have documented mutagenic and teratogenic effects. The placental transfer of compounds decreases with increased molecular weight, increasing electrical charge, and decreasing lipid solubility. The susceptibility of the fetus to teratogenic effects depends upon: (1) the properties of the agent administered; (2) the time of administration of the agent, with the most critical period being that of organ differentiation; (3) the size of the dose received; (4) the number of doses given; (5) the route of administration to the mother; and (6) other factors, such as the general health of the mother (72). The lack of certain liver microsomal enzyme systems may predispose the infant to the toxic effects of substances which are not oxidized and excreted as rapidly as normal. For example, a fetus is more susceptible to the effects of alcohols and phenols if the glucuronidation system is impaired (21). Conditions associated with an incomplete or improper glucuronide conjugation system are Gilbert's syndrome and the Crigler and Najjar syndrome.

A two-year study of mothers with children having central-nervous-system defects was conducted examining the percent of mothers known to have had exposure to organic solvents (47). The results of the study indicated that significantly more "case-mothers" than "control-mothers" had been exposed to organic solvents during the first trimester of pregnancy.

Reviews on the risks of pregnancy posed by environmental contaminants have been provided by a number of sources (79,72,33,35,21). The discussions by these authors on the teratogenic properties of biphehyls center on the findings of the animal studies and the "Yusho" incident presented elsewhere in this review.

III. Summary

Environmental studies have shown PCBs to be extremely stable compounds in the environment. Their lipophilic properties allow bioaccumulation in aquatic foodchains with man, or more accurately the nursing infant, at the top of the trophic scale. Testimony to the ubiquitous nature of PCBs is found in the results of the Human Monitoring Survey. A significant proportion of the U.S. general population sampled have detectable amounts of PCBs in their adipose tissues. Exposure routes for the general population include ambient air, ambient waters, contaminated soils, occupational sources, and diet. The latter two categories may provide the most concentrated exposures. Workers in PCB-manufacturing industries have experienced dermatological, central-nervous-system, and diffuse symptomatologies. The study designs which have provided these results have not evaluated the long-term, low-level toxic effects of PCBs.

Dietary studies conclude that the two food items which may provide high concentrations of PCBs are fish and human breast milk. The physiological consequences of ingesting high quantities of PCBs are best exemplified by the "Yusho" incident. Their patients demonstrated acniform lesions, skin pigmentation, and increased eye discharge. Those women exposed during pregnancy had "small-for-date" children with "cola"-colored skin and gingiva. Their infants were noted to have a high prevalence of neonatal jaundice and increased ocular discharge (71). It must be noted that the rice oil was also contaminated with polychlorinated dibenzofurans, which are known to have toxic properties.

The primary source of PCBs in the U.S. diet is fish acquired from contaminated areas. The study by Humphrey and others (52) has documented that Michigan sport fish consumers eat approximately 10 pounds more per person per year than the average U.S. citizen. The findings also demonstrated a positive correlation between serum PCB levels and the amount of fresh fish consumed. It may be hypothesized that the PCB concentrations in human breast milk increase with the total body burden of the nursing mother. Therefore, a mother who consumes large quantities of contaminated fish may present a greater exposure potential to the breast-fed infant.

The articles reviewed indicate that consumers of fish from contaminated waters and infants breast-fed by those consumers warrant further study. The physiological consequences of long-term, low-level exposure to PCBs in these populations are currently unknown. Therefore the efforts of the Great Lakes project have focused on data gathering and quantitative analysis to determine whehter contact with contaminants in the Great Lakes has been detrimental to local populations. Initial data evaluations were conducted on State Vital Statistics records. As these documents do not indicate relative exposure potentials, a pilot study was conducted to identify fish consumers. Summaries of the data evaluations and pilot project are presented in the following sections.

Analyses of Morbidity and Mortality Patterns of Populations Living in the Eight Great Lakes States

Five quantitative analyses have been performed by the Great Lakes Project Staff. The purpose of these data evaluations has been to compare, by geographical area, specific disease and death rates in the Great Lakes Basin. The morbidity and mortality parameters examined were those likely to reflect human exposure to organic compounds. Reviews were based on cancer death rates, congenital anomaly rates, and fetal, neonatal, and infant death rates. Vital Statistics data were not available on these indices for all Great Lakes states. Pennsylvania and New York have collated their records in a manner which is not readily accessible.

The geographical unit which served as a basis for comparison was the county. The counties within each state were separated into three "Orders." Order 1 counties were those which contain shoreline on one or more Great Lakes. Order 2 consists of counties which are adjacent to Order 1 counties. All other counties in the eight Great Lakes states were considered as Order 3. Comparisons of mortality and morbidity rates were made between Order 1 counties and the respective state mean rates, and between Order 1 counties and those of Order 2 and 3. The contrasting of rates by geographical proximity to the Great Lakes was based on the hypothesis of a "graded exposure potential." That is, populations in proximity to contaminated areas of the Great Lakes are more likely to be exposed to contaminants than populations residing at greater distances.

In summary, the results of these studies demonstrate a trend toward increased esophageal, stomach and "other gastro-intestinal" cancer mortality in Order 1 counties when compared to respective state mean rates. It may be hypothesized that the detrimental health effects of exposure to organic contaminants in the Great Lakes may be masked by pollutants associated with urbanization in cities adjacent to the lakes. When counties with large urban centers were removed from the above analysis, a greater percentage of Order 1 counties continued to experience an excess of esophageal, stomach, and bronchus, trachea and lung combined, as well as all-cancer mortality over the respective state mean rates.*

The comparisons between Order 1 and Order 2 mean county cancer mortality rates demonstrated excesses in white males and females for the site of esophagus (31% and 26%, respectively). White males also demonstrated excesses for the sites of breast (46%) and thyroid gland (42%). A 68% excess in mortality due to cancer of the endocrine organs was found in white females. The county comparisons between Orders 1 and 3 found an excess of esophagal cancer for Order 1 white males (44%) and females (32%). The respective values for stomach cancer mortality excesses were 35% and 24%.

In addition, there were no striking discrepancies between the fetal death rate, the neonatal death rate, and the percent of live births with congenital anomalies, among "lake-bordering" and "non-lake bordering" counties.

For each of the five analyses an introduction, description of methods, summary of results, and discussion section is presented below.

I. Analysis 1.

A. Introduction

The first step in attempting to ascertain an adverse human health effect from contamination of the Great Lakes required the utilization of existing morbidity/mortality data sets acquired from state and federal agencies. County vital statistics regarding fetal, neonatal, and infant death rates and congenital anomaly rates were obtained for the states of Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio for every fifth year from 1950 to 1975 and for the year 1977. County data for site, race, sex, and age-adjusted cancer mortality rates were acquired from the National Cancer Institute's publication "U.S. Cancer Mortality: 1950-1969." (80)

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* Results are for white males only.

The hypothesis for this study was that populations residing in areas immediately adjacent to the Great Lakes experienced a greater exposure potential to lake contaminants than populations residing in areas more distant from the lakes. This hypothesis was based on the following assumptions:

1. Most "lake bordering" communities have increased industrial activity compared to most "non-lake bordering" communities.
2. Individuals living in these "lake bordering" communities were more likely to be occupationally exposed to those pollutants being discharged into the air and lakes.
3. Close proximity to the Lakes would lead to greater exposure via ambient air, soils, and water.
4. Fishermen living in these lake-adjacent communities were more likely to fish these lakes and may have had higher exposures due to consumption of their catch.

The analytic evaluations performed on the above mentioned data sets have incorporated the concept of a graded exposure potential.

B. Methods

The initial evaluation of the above data sets was performed in the following manner:

1. Counties within each of the Great Lakes states were designated as either bordering the Great Lakes (hereafter termed "lake bordering") or not bordering the Great Lakes (hereafter termed "non-lake bordering").
2. Within each state, a mean rate for "lake bordering" counties was calculated for each of the mortality and morbidity parameters listed above. For example, the mean infant mortality rate for "lake bordering" counties in Minnesota was calculated by summing the infant mortality rates for each of the Minnesota "lake bordering" counties and dividing this sum by the number of "lake bordering" counties in Minnesota.
3. Correspondingly, a mean rate for "non-lake bordering" counties was claculated for each mortality/morbidity index within each state.
4. For each of the health parameters of interest, a mean state rate was calculated by summing the respective rates for all counties within the state and dividing this sum by the total number of state counties. The standard error of each state mean was calculated.

A description of the data sources, methods of analysis, and results of this phase of the Great Lakes Project may be found in the October 16, 1978-June 15, 1979 Progress Report to the Environmental Protection Agency. A copy of this report is included as Appendix VI.

C. Results

An excess of esophageal, stomach, and "other gastro-intestinal" cancer mortality was noted in "lake bordering" counties. However, tests of statistical significance were not calculated for observed differences. The comparisons of infant, neonatal, and fetal death rates for the six states noted above were inconclusive as they were not adjusted for maternal age nor stratified by sex or race.

D. Discussion

Many of the "lake bordering" counties have large urban centers. The excess esophageal, stomach, and "other gastro-intestinal" cancer mortality in these areas may be due to factors intrinsic to urbanization rather than potential exposure to toxic substances in the lakes. The possible confounding influence of urbanization is addressed in a later analysis.

II. Analysis 2.

A. Introduction

The amount of organic compounds found in industrial and wastewater treatment plant effluents are monitored by state governments. A summary of these records are found in the "Inventory of Major Municipal and Industrial Point Source Dischargers in the Great Lakes Basin." (56) Knowing the levels of contaminants being released into set geographical areas provides an approximation to the exposure potential of the respective communities. It was hypothesized that those counties with point-source dischargers of hazardous materials in compliance with state effluent requirements may have different cancer rates than those counties whose dischargers fail to comply with state requirements. The following analysis was initiated to determine if correlations exist between the recorded levels of organic compounds in industrial and wastewater treatment plant effluents and the cancer mortality rates for the respective county.

B. Methods

For each of the eight Great Lakes states the five respective counties with the highest cancer mortality rates in 1950-1969 for either esophageal, stomach, lung, and all neoplasms were designated as list number I. The communities listed in the inventory above were allocated to the following four categories in list number II:

1. communities with at least one industry measuring organic compounds (i.e., phenols) prior to discharge and complying with state effluent requriements, and in which the wastewater treatment plants complied with state effluent requirements on the basis of phosphorus (P), biological oxygen demand (BOD), and suspended solids (SS).
2. communities with at least one industry measuring organic compounds (i.e., phenols) prior to discharge and failing to comply with state effluent requirements, and in which a wastewater treatment plant failed to comply with state effluent requirements (on the basis of P, BOD, and SS).
3. communities with at least one industry measuring organic compounds (i.e., phenols) prior to discharge and failing to comply with state effluent requirements, and in which the wastewater treatment plants complied with state effluent requirements (on the basis of P, BOD, and SS).
4. communities with at least one industry measuring organic compounds (i.e., phenols) prior to discharge and complied with state effluent requirements, and in which a wastewater treatment plant failed to comply with state effluent requirements (on the basis of P, BOD, and SS).

5. The counties of high cancer mortality in list I were matched geographically to the four categories of dischargers in list II. For example, county X has one of the five highest rates of esophageal cancer in Ohio. List II was then examined to see if county X had a discharger. If yes, then the name of the county and the category in which the discharger appeared was noted in a third list.
6. Counts of the number of counties represented in each of the four categories of dischargers were performed.

C. Results

The results indicated that counties with non-compliant communities experienced higher stomach and kidney cancer mortality rates in white males and high "nose, auxiliary sinus, etc." cancer mortality rates in non-white males. Counties with compliant communities had elevated "nose, auxiliary sinus, etc." cancer mortality rates in white males and females. A full account of the analytical methods and results are presented in the "Preliminary Report of Epidemiological and Environmental Data" dated April 4, 1980 by the University of Minnesota Division of Epidemiology. A copy is included in Appendix VI.

III. Analysis 3.

A. Introduction

As the first analysis did not address the possible confounding influence of urban pollutants in the examination of mean fetal, neonatal, infant, and all sites cancer death rates for "lake bordering" versus "non-lake bordering" counties, an examination of the same data sets was initiated omitting all counties within the Great Lakes states having population centers greater than 100,000 inhabitants.

B. Methods

A straightforward approach to utilizing the prior results was to identify the percent of rural "lake bordering" counties versus rural "non-lake bordering" counties, for the Great Lakes Basin, which demonstrated either one standard deviation excess or one standard deviation deficit from respective state means for 1977 white male esophageal, stomach, lung, and all cancer mortality rates. An identical evaluation was performed for the percent live births with congenital anomalies, fertility rates, neonatal death rates, and fetal death rates when data were available.

A total of 37 counties having population centers of greater than 100,000 inhabitants were omitted from the analysis leaving 72 "rural" lake bordering and 538 "rural" non-lake bordering counties in the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin.

C. Results

Table 13shows the percentages of rural "lake bordering" counties having at least one standard deviation higher mortality/morbidity and those with at least one standard deviation lower mortality/morbidity than their respective state mean rates. A larger percent of "lake bordering" counties had rates in excess of one or more standard deviations (as compared to the respective state means) than did "non-lake bordering" counties for the 1977 white male cancer sites of esophagus, stomach, bronchus, trachea and lung, and all-sites combined. The corresponding values are 16.67%, 13.9%, 8.3%, and 9.72% versus 3.5%, 3.9%, 3.53%, and 3.16% respectively. The percent of counties with rates for "Live Births With Congenital Anomalies" demonstrated an opposite trend with a greater percentage of "non-lake bordering" counties having rates equal to or greater than one standard deviation than "lake

TABLE 13

Percent of Lake Bordering and Non-Lake Bordering Counties Having Morbidity/Mortality Rates Discrepant by ≥1 Standard Deviation From State Means

	Cancer Sites				Reproductive Parameters			
	Esophagus	Stomach	Bronchus, Trachea, & Lung	All Cancers	Fertility Rate	% of Live Births with Congenital Anomalies	Neonatal Death Rate	Fetal Death Rate
Percent of 72 "lake bordering" counties having rates ≥ 1 standard deviation higher than their respective state mean rates	16.67	13.9	8.3	9.72	*	3.64	4.69	7.81
Percent of 72 "lake bordering counties having rates ≥ 1 standard deviation lower than their respective state mean rates	4.17	4.17	6.9	4.17	*	7.27	9.38	7.81
Percent of 538 "non-lake bordering" counties having rates ≥ 1 standard deviation higher than their respective state mean rates	3.5	3.9	3.53	3.16	*	7.43	6.25	6.0
Percent of 538 "non-lake bordering" counties having rates ≥ 1 standard deviation lower than their respective state mean rates	7.8	6.7	6.51	7.06	*	6.86	8.56	10.4

* Data unavailable

bordering" counties. The percent of counties with rates above one standard deviation and below one standard deviation for "lake bordering" as compared with "non-lake bordering" are: 3.64% above and 7.27% below, and 7.43% above and 6.86% below one standard deviation, respectively. The percentage values for the "Neonatal Death Rate" are 4.69 and 9.38, and 6.25 and 8.56, respectively. The pattern of percentages for the "Fetal Death Rate" is the same as the pattern for the cancer sites. The corresponding values are: 7.81 and 7.81, and 6.0 and 10.4. The fertility rates for the eight states were not analyzed due to inconsistent reporting between states.

D. Discussion

The results of this analysis indicate that when comparing counties without population centers of 100,000 inhabitants to the state mortality/morbidity rates, the "lake bordering" counties have a greater probability of experiencing extreme rates in those outcomes of morbidity/mortality reviewed than do "non-lake bordering" counties. For example, a rural "lake bordering" county is 5.46 times as likely as a rural "non-lake bordering" county to have a 1977 white male esophageal cancer rate one standard deviation above its respective state mean. Hypotheses drawn from this third anlaysis should be guarded. The cancer rates are for white males in 1977 and may not be indicative of cancer mortality patterns of other years, races, or women. The available state vital statistics data regarding reproductive parameters were limited to a few states, therefore, results are based on a small number of reporting counties.

IV. Analysis 4.

A. Introduction

Since the results cited above warranted further investigation, the analytical strategies were refined so that comparisons could be made between the rural "lake bordering" versus the rural "non-lake bordering" county age-adjusted cancer mortality rates for specific anatomical sites.

B. Methods

For each of the eight states in the Great Lakes Basin an average age-adjusted site-sex-race specific cancer mortality rate per 100,000 was computed for the rural "lake bordering" counties and the rural "non-lake bordering" counties. The mean of the eight averaged age-adjusted site specific cancer mortality rates per 100,000 people was calculated to produce a summary rate for "lake bordering" counties of the Great Lakes Basin. This procedure was followed to provide similar summary values for "non-lake bordering" counties.

C. Results

Table 14 presents the summary mean rates, their standard deviations, and the differences and ratios between means for the rural "lake bordering" and the rural "non-lake bordering" counties.

The ratio of "lake bordering" to "non-lake bordering" mean age-adjusted cancer rates (hereafter termed ratio) of the esophagus for white males is 1.468. The corresponding ratio for white females is 1.0374 and .5134 for both non-white sexes. The ratios for stomach cancer rates are 1.2513 for white males, 1.1116 for white females, and 1.0759 for non-whites of both sexes. The corresponding ratios for bronchus, trachea, and lung cancers are 1.1521 for white males, .9979 for white females, and 1.0691 for non-whites of both sexes. The corresponding ratios for the category of all malignant neoplasms are 1.09777, 1.0339, and 1.0734 respectively.

The ratio for whites demonstrating the largest relative disparity (47%) between "lake bordering" and "non-lake bordering" counties is for esophageal cancer in white males (1.468). The second largest relative

TABLE 14

Means, Standard Deviations, and Comparisons of Mean Age-Adjusted Cause-Sex-Race-Specific Mortality Rates Per 100,000 for Rural "Lake Bordering" and Rural "Non-Lake Bordering" Counties of the Great Lakes Basin.

	Esophageal Cancer				Stomach Cancer				Bronchus, Trachea & Lung Cancer				All Neoplasms			
	White			Non White	White			Non White	White			Non White	White			Non White
	M	F	Both Sexes	Both Sexes	M	F	Both Sexes	Both Sexes	M	F	Both Sexes	Both Sexes	M	F	Both Sexes	Both Sexes
Mean rural "Lake Bordering" mortality rate for all 8 states. $(\bar{B})$	4.44	.796	5.24	6.08	18.55	8.41	26.97	24.29	33.28	5.08	38.36	32.59	170.35	132.19	302.19	271.27
Standard Deviation	.7767	.3003	.8536	3.8835	3.2833	1.6585	4.548	12.958	5.487	.9448	6.2895	25.8836	7.8171	3.0066	10.5188	110.0538
Mean rural "Non Lake Bordering" mortality rate for all 8 states. $(\bar{N})$	2.99	.768	3.756	11.836	14.824	7.561	22.385	22.579	28.888	5.094	33.982	30.482	155.184	127.856	283.04	252.73
Standard Deviation of summary mean	.4649	.1424	.5652	19.725	2.3426	1.3468	3.6332	9.8951	6.008	.6288	6.5547	12.6605	9.0133	4.3542	12.8555	77.1197
Difference of: $(\bar{B} - \bar{N})$	1.4523	.0287	1.481	-5.759	3.725	.8436	4.584	1.714	4.393	-.0108	4.383	2.1053	15.167	4.331	19.498	18.542
Ratio of: $(\bar{3}/\bar{N})$	1.468	1.0374	1.3943	.5134	1.2513	1.1116	1.2048	1.0759	1.1521	.9979	1.129	1.0691	1.0977	1.0339	1.0689	1.0734

disparity (25%) is for stomach cancer in while males. The remaining ratios have values approaching unity. The cancer ratios for non-whites should be viewed sceptically as they are based upon very small numbers of deaths.

D. Discussion

These results indicate that white populations of "lake bordering" counties experience larger averaged cancer rates for every category examined, (except for bronchus, trachea and lung cancers in females) than did white populations of "non-lake bordering" counties. The methodological approach of comparing average cancer rates, as opposed to the percentage of counties with rates greater than one standard deviation above respective state means, is a more direct approach in examining the amount of difference in the mortality experiences of the two geographical areas.

The results of the third and fourth analyses suggest that when counties with large urban centers are removed from consideration, specific sites show higher cancer mortality in those counties which border the Great Lakes than in those counties which do not border the Great Lakes. The findings of the four analyses were consistent in revealing elevated esophageal and stomach cancer mortality rates in "lake bordering" counties.

V. Analysis 5.

A. Introduction

A fifth evaluation of the 1950-1969 county cancer mortality rates was undertaken to determine if the above disparities would be demonstrated under a decidedly more complex and costly analytical method. Animal toxicity studies have demonstrated that many types of cancers may result from exposure to organic chemicals. Therefore, it was decided to examine rigorously all thirty-five cancer sites reported in the NIH county 1950-1969 cancer mortality data (80). The analytical procedure encompassed the following methods:

B. Methods

1. All age-adjusted site-race-sex-specific cancer rates for each county in the eight Great Lakes States were extracted from the NIH 1950-1969 county cancer mortality data set (80).
2. The counties of the eight Great Lakes states were divided into three "Orders." First Order counties are those counties which are adjacent to the Great Lakes ("lake bordering counties"). Second Order counties are those counties adjacent to these "lake bordering" counties. Third Order counties are considered to be all remaining counties of the eight Great Lakes states. The listing of state counties by Order is presented in Table 15.
3. The 1960 population census figures were obtained for each of the three Orders. Population counts within each Order were totaled for white males, white females, non-white males, and non-white females. (See Tables 16and 17). The population counts for 1960 were used in a later step as weighting factors for the refinement of summary cancer rates. The 1960 census figures were utilized as this year represents the midpoint of the twenty year data collection period for the NIH 1950-1969 county cancer mortality data set (80).
4. The age-adjusted site-race-sex specific county cancer mortality rates were summed within each Order and then divided by the total number of counties within the respective Order to yield average age-adjusted site-race-sex specific mortality rates for each of the three Orders.
5. "Risk" ratios were then calculated comparing Orders one to two,

TABLE 15

Counties Designated as the 1st, 2nd, and 3rd Orders by State

1st Order = Lake Bordering Counties
2nd Order = Adjacent to Lake Bordering Counties
3rd Order = Inland Counties (remaining counties)

Pennsylvania

1st	2nd	3rd
Erie	Crawford Warren	(All remaining)

1st Order = 1
2nd Order = 2
3rd Order = 64

Total number of counties = 67

Counties omitted for "rural" analysis

1st	2nd	3rd
Erie	--	Allegheny Philadelphia Lehigh Lackawanna

1st Order = 0
2nd Order = 2
3rd Order = 60

Total number of counties = 62

Illinois

1st	2nd	3rd
Lake Cook	Will Dupage Kane McHenry	(All remaining)

1st Order = 2
2nd Order = 4
3rd Order = 96

Total number of counties = 102

TABLE 15 (Continued)

Counties omitted for "rural" analysis

1st	2nd	3rd
Cook	--	Winnebago Peoria

1st Order = 1
2nd Order = 4
3rd Order = 94

Total number of counties = 99

Indiana

1st	2nd	3rd
Lake Porter La Porte	St. Joseph Starke Jasper Newton	(All remaining)

1st Order = 3
2nd Order = 4
3rd Order = 85

Total number of counties = 92

Counties omitted for "rural" analysis

1st	2nd	3rd
Lake	St. Joseph	Allen Marion Vanderburgh

1st Order = 2
2nd Order = 3
3rd Order = 82

Total number of counties = 87

TABLE 15 (Continued)

Michigan

1st	2nd	3rd
Berrien	Cass	(All remaining)
Van Buren	Kalamazoo	
Allegan	Barry	
Ottawa	Kent	
Muskegon	Newaygo	
Oceana	Lake	
Mason	Wexford	
Manistee	Kalkaska	
Benzie	Otsego	
Leelanau	Montmorency	
Grand Traverse	Oscoda	
Antrim	Ogemaw	
Charlevoix	Gladwin	
Emmet	Midland	
Cheboygan	Saginaw	
Presque Isle	Genesee	
Alpena	Lapeer	
Alcoma	Oakland	
Iosco	Washtenaw	
Arenac	Lenawee	
Tuscola	Iron	
Huron	Dickinson	
Bay		
Sanilac		
St. Clair		
Macomb		
Wayne		
Monroe		
Gogebic		
Ontonagon		
Houghton		
Keweenaw		
Baraga		
Marquette		
Alger		
Luce		
Chippewa		
Mackinac		
Schoolcraft		
Delta		
Menominee		

1st Order = 41
2nd Order = 22
3rd Order = 20

Total number of counties = 83

TABLE 15 (Continued)

Counties omitted for "rural" analysis

1st	2nd	3rd
Macomb	Genesee	Ingham
Wayne	Kent	

1st Order = 39
2nd Order = 20
3rd Order = 19

Total number of counties = 78

Minnesota

1st	2nd	3rd
Cook	Koochiching	(All remaining)
Lake	Itasca	
St. Louis	Aitkin	
	Carlton	

1st Order = 3
2nd Order = 4
3rd Order = 80

Total number of counties = 87

Counties omitted for "rural" analysis

1st	2nd	3rd
St. Louis	--	Hennepin
		Ramsey

1st Order = 2
2nd Order = 4
3rd Order = 78

Total number of counties = 84

TABLE 15 (Continued)

New York

1st	2nd	3rd
St. Lawrence	Franklin	(All remaining)
Jefferson	Herkimer	
Oswego	Lewis	
Cayuga	Oneida	
Wayne	Madison	
Monroe	Onondaga	
Niagara	Cortland	
Erie	Seneca	
Chautaugua	Ontario	
Orleans	Livingston	
	Genesee	
	Wyoming	
	Cattaraugus	
	Tompkins	
	Hamilton	

1st Order = 10
2nd Order = 15
3rd Order = 33

*Total number of counties = 58

Counties omitted for "rural" analysis

1st	2nd	3rd
Erie	Onandaga	Albany
Monroe		New York
		Westchester

1st Order = 8
2nd Order = 14
3rd Order = 30

Total number of counties = 52

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* The "U.S. Cancer Mortality by County 1950-1969" includes Bronx, Kings, Queens, and Richmond counties as New York. All these counties will be omitted in the "rural" analysis.

TABLE 15 (Continued)

Ohio

1st	2nd	3rd
Lucas	Fulton	(All remaining)
Ottawa	Henry	
Erie	Wood	
Lorain	Seneca	
Cuyahoga	Huron	
Lake	Ashland	
Ashtabula	Medina	
Sandusky	Summit	
	Trumbull	
	Geauga	

1st Order = 8
2nd Order = 10
3rd Order = 70

Total number of counties = 88

Counties omitted for "rural" analysis

1st	2nd	3rd
Lucas	Summit	Hamilton
Cuyahoga		Mahoning
		Montgomery
		Stark
		Franklin

1st Order = 6
2nd Order = 9
3rd Order = 65

Total number of counties = 80

TABLE 15 (Continued)

Wisconsin

1st	2nd	3rd
Douglas	Burnett	(All remaining)
Bayfield	Washburn	
Ashland	Sawyer	
Iron	Price	
Marinette	Vilas	
*Menominee	Florence	
Door	Forest	
Brown	Langlade	
Kewaunee	Calumet	
Manitowoc	Fond du Lac	
Sheboygan	Outagamie	
Ozaukee	Washington	
Milwaukee	Waukesha	
Racine	Walworth	
Kenosha		

1st Order = 15
2nd Order = 14
3rd Order = 41

Total number of counties = 70

Counties omitted for "rural" analysis

1st	2nd	3rd
Milwaukee	--	Dane

1st Order = 14
2nd Order = 14
3rd Order = 40

Total number of counties = 68

*Note: Menominee County did not exist in 1960. In: "U.S. Cancer Mortality by County 1950-1969," Menominee includes Oconto and Shawano counties. For purposes of this analysis Menominee will be defined as lake bordering with a population comprised of Oconto and Shawano counties.

TABLE 16
SUMMARY POPULATION FIGURES FOR THE GREAT LAKES BASIN BY ORDER, SEX, AND RACE (1960)

State	1st Order White		2nd Order White		3rd Order White	
	Male	Female	Male	Female	Male	Female
PA	119,286	124,271	59,727	62,639	4,914,866	5,173,215
MN	123,469	122,868	48,766	45,797	1,499,258	1,531,445
WI	858,142	880,945	267,546	267,636	792,511	792,123
MI	1,947,589	1,970,115	1,092,906	1,115,276	479,927	480,052
IL	2,224,186	2,297,648	386,717	392,361	1,824,784	1,884,556
IN	291,740	284,230	136,211	136,232	1,737,558	1,802,583
NY	1,161,664	1,217,220	628,895	642,894	5,630,805	6,005,593
OH	1,174,091	1,225,393	518,444	532,039	2,683,591	2,776,140
Total:	7,900,167	8,122,690	3,139,212	3,194,874	19,563,300	20,445,707
Male + Female =	16,022,857		6,334,086		40,009,007	

	Nonwhite		Nonwhite		Nonwhite	
	Male	Female	Male	Female	Male	Female
PA	3,465	3,660	614	558	411,893	445,172
MN	1,184	1,146	912	815	19,373	18,831
WI	39,529	40,254	2,122	2,166	4,662	4,141
MI	285,152	300,536	60,232	61,396	17,062	12,951
IL	432,809	468,738	10,768	7,686	73,602	77,303
IN	45,377	47,312	7,007	7,419	80,405	85,984
NY	59,964	61,155	15,239	14,022	626,672	718,181
OH	156,892	167,526	28,092	29,120	203,118	211,951
Total:	1,024,372	1,090,327	124,986	123,182	1,437,227	1,574,514
Male + Female =	2,114,699		248,168		3,011,741	

Totals: Male and Female by Order and State

	1st Order		2nd Order		3rd Order		State Population Totals
	Male	Female	Male	Female	Male	Female	
PA	122,751	127,931	60,341	63,197	5,326,759	5,618,387	11,319,366
MN	124,653	124,014	49,678	46,631	1,518,631	1,550,276	3,413,864
WI	897,671	921,199	269,668	269,802	797,173	796,264	3,951,777
MI	2,232,741	2,270,651	1,153,138	1,176,672	496,989	493,003	7,823,194
IL	2,656,995	2,766,386	397,485	400,047	1,898,386	1,961,859	10,081,158
IN	337,117	331,542	143,218	143,651	1,818,403	1,888,567	4,662,498
NY	1,221,628	1,278,375	644,134	656,916	6,257,477	6,723,774	16,782,304
OH	1,330,983	1,392,919	564,536	561,159	2,886,709	2,988,091	9,706,397
Total:	8,924,539	9,213,017	3,264,198	3,318,056	21,000,527	22,020,221	67,740,558
Male + Female =	18,137,556		6,582,254		43,020,748		

TABLE 17

SUMMARY POPULATION FIGURES FOR THE GREAT LAKES BASIN BY ORDER, SEX, AND RACE (1960)

Counties with urban centers containing populations >100,000 are omitted

State	1st Order White		2nd Order White		3rd Order White	
	Male	Female	Male	Female	Male	Female
PA	0	0	59,727	62,639	3,264,038	3,403,683
MN	8,799	8,078	48,766	45,797	905,024	886,921
WI	384,322	385,501	267,546	267,636	683,775	681,517
MI	695,625	692,888	755,820	767,188	379,688	377,182
IL	147,938	133,023	386,717	392,361	1,639,041	1,690,666
IN	75,954	74,375	24,526	23,654	1,267,409	1,299,659
NY	410,795	421,326	428,824	434,031	1,958,806	2,029,110
OH	297,147	299,504	286,631	291,950	1,519,389	1,547,862
Total:	2,020,580	2,014,695	2,258,557	2,285,256	11,617,170	11,916,600
Male + Female =	4,035,275		4,543,813		23,533,770	

PA	0	0	614	558	91,388	92,871
MN	110	92	912	815	6,004	5,579
WI	6,608	6,398	2,122	2,166	3,114	2,936
MI	21,737	21,041	34,300	35,002	12,849	8,977
IL	6,401	6,294	10,768	7,686	64,395	67,334
IN	2,861	2,200	40	35	22,522	21,823
NY	8,830	7,977	8,183	6,984	63,116	66,418
OH	11,191	11,234	7,734	7,811	47,247	45,314
Total:	57,738	55,236	64,673	61,057	310,635	311,252
Male + Female =	112,974		125,730		621,887	

Totals: Male and Female by Order and State

	1st Order		2nd Order		3rd Order		State Population Totals
	Male	Female	Male	Female	Male	Female	
PA	0	0	60,341	63,197	3,355,426	3,496,554	6,975,518
MN	8,909	8,170	49,678	46,612	911,028	892,500	1,916,897
WI	390,930	391,899	269,668	269,802	686,889	684,453	2,693,641
MI	717,362	713,929	790,120	802,190	392,537	386,159	3,802,297
IL	154,339	139,317	397,485	400,047	1,703,436	1,758,000	4,552,624
IN	78,815	76,575	24,566	23,689	1,289,931	1,321,482	2,815,058
NY	419,625	429,303	437,007	441,015	2,021,922	2,095,528	5,844,400
OH	308,338	310,738	294,365	299,761	1,566,636	1,593,176	4,373,014
Total:	2,078,318	2,069,931	2,323,230	2,346,313	11,927,805	12,227,852	32,973,449
Male + Female =	4,148,249		4,669,543		24,155,657		

one to three, and two to three. A "risk" ratio was defined as the division of an averaged age-adjusted site-race-sex specific cancer mortality rate for a given Order divided by the corresponding average rate of a different Order.

6. Each average age-adjusted site-race-sex specific cancer mortality rate was then multiplied by the census figure for the respective race, sex, and Order. This product was then divided by the total population figure for the respective sex and race of the eight Great Lakes states. This quotient represents a population weighted average age-adjusted site-race-sex specific cancer mortality rate by Order.
7. "Weighted risk" ratios were calculated comparing the average rate for each of the Orders to the overall rate for the eight Great Lakes states. A "weighted risk" ratio was defined as the division of the average age-adjusted site-race-sex specific cancer mortality rate for a given Order by the sum of the three weighted average age-adjusted site-race-sex specific cancer mortality rates for a given Order.

(The calculations and data derived from steps 4 through 7 will hereafter be termed the "urban and rural" analysis.)

8. Steps 4 through 7 were repeated omitting all counties within the eight Great Lakes states having population centers of 100,000 or more inhabitants.

(The calculations and data derived from step 8 will hereafter be termed the "rural" analysis.)

9. The average age-adjusted site-race-sex specific cancer mortality

rates for the "rural" and "urban and rural" analyses were examined for disparities of increasing or decreasing mortality rates by degree of geographical contiguity to the Great Lakes. (e.g., Which cancer sites have higher mortality rates in the first Order counties than second Order counties, which in turn have higher rates than the third Order counties?)

C. Results

The rates[3] computed for each of the thirty-five sites for both the "urban and rural" and "rural" analyses are presented in Appendix I. A summary of Appendix I is given below. Only the most extreme ratio values for non-white populations will be presented as most non-white rates were based on relatively small numbers of deaths.

1. "Urban and Rural" Analysis

"Risk" Ratios: Order 1 counties had a 31% excess of esophageal cancer mortality in white males and a 26% excess in white females over Order 2 counties. A 68% excess in mortality due to cancer of other endocrine organs for white females and a 46% excess for breast cancer mortality in white males was noted in Order 1 over Order 2. The "risk" ratio of Order 1 to Order 2 county nasopharyngeal cancer mortality rates was 3.66 for non-white males and 7.74 for non-white females. The corresponding ratios for esophageal cancer in non-whites was 1.64 and 0.04 respectively. Non-white rate ratios for Order 1 to Order 2 counties were 5.36 for thyroid cancer in males and 8.59 for brain and other nervous system cancers in females.

A "risk" ratio of 40.14 in non-white females for esophageal cancer

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3) All rates, ratios, and percentages quoted in this analysis are in respect to mortality and not incidence.

mortality was noted when comparing Order 2 to Order 3 counties. White males experienced 42% higher recorded thyroid gland cancer mortality in Order 1 than Order 2.

The "risk" ratios comparing rates in Order 1 to Order 3 counties indicated an excess of esophageal cancer mortality for white males of 44%; for white females, 32%; non-white males, 41%; and 58% for non-white females. The corresponding values for stomach cancer were 35%, 24%, 79%, and 33% respectively. The ratio of rates for Order 1 to Order 3 counties for lip cancer mortality in non-white females was 5.33, 5.73 for "other" skin cancers in non-white males, and 8.05 for lymphosarcoma* in non-white males.

"Weighted Risk" Ratios: The ratio of the rates in Order 1 counties to the sum of all the weighted rates for esophageal cancer mortality were 1.28 for white males, 1.21 for white females, and 1.22 for non-white males. The corresponding ratios for stomach cancer were 1.22, 1.16, and 1.34 respectively. White females demonstrated a risk of 0.1116 for mortality due to cancer of the nose, nasal cavities, middle ear, and accessory sinuses. The "weighted risk" ratio for lymphosarcoma* in non-white males was 2.08. Non-white females had a ratio of 2.56 for cancers of the connective tissues.

The mortality ratio of rates in Order 2 counties to the sum of all the weighted rates for non-white males was 2.21 for rectal cancer, 5.64 for breast cancer, 3.22 for cancers of the eye, 5.06 for bone* cancers, and 3.88 for Hodgkin's disease. The corresponding ratios for non-white females were 2.62 for salivary gland cancers, 13.58 for esophageal cancer, and 2.07 for melanomas of the skin.

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* See the NIH publication (80) for a complete listing of cancers included in this category.

The ratio of rates in Order 3 counties to the sum of all the weighted rates for non-white male tongue and mouth cancers was 1.46. Non-white females demonstrated a ratio of 4.50 for cancers of the connective tissue.

2. "Rural" Analysis

"Risk" Ratios: White males experienced 27% more salivary gland cancer, 26% more esophageal cancer, and 48% more breast cancer mortality in Order 1 counties than in Order 2 counties. Order 1 county white females experienced proportionately greater mortality than Order 2 county white females for salivary gland cancer (20%), esophageal cancer (27%), nose and middle ear* cancers (30%), and cancer of the endocrine organs (73%). The esophageal "risk" ratios for non-whites was 1.78 for males and 0.03 for females. The corresponding non-white ratios for cancer mortality due to brain and other nervous system* cancers were 2.02 and 10.52. The percent of excess mortality in Order 1 over Order 2 counties for non-white males was 393% for nasopharyngeal cancer, 188% for other skin cancers,* 102% for brain and other nervous system* cancers, 152% for thyroid cancers, 279% for lymphosarcoma and 122% for I.C.D. codes not listed.* Non-white females also experienced proportionately greater mortality in Order 1 than Order 2 counties for the cancer sites of pancreas (332%), nose and middle ear* (120%), brain and other nervous system* (951%), Hodgkin's disease (114%), and multiple myeloma (222%).

The "risk" ratios comparing rates in Order 2 to Order 3 counties have the following values: for white males the thyroid cancer mortality ratio was 1.44; non-white male mortality ratios were 1.91 for rectal cancer, 8.55 for breast cancer, 2.16 for bladder cancer, 2.27 for other skin cancers,*

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* See the NIH publication (80) for a complete listing of cancers included in this category.

3.29 for cancer of the eye, 5.38 for bone cancer, and 5.59 for Hodgkin's disease. The corresponding ratios for non-white females included 2.13 for salivary gland cancers, 47.124 for esophageal cancer, 2.31 for stomach cancer, and 2.58 for cancer of the cervix uteri.

In the comparison of Order 1 to Order 3 counties, excess cancer mortality was noted for the sites of esophagus (39%), stomach (36%), larynx (31%), and thyroid gland (33%) for white males. The corresponding percentages for white females were esophagus (33%), stomach (24%), and endocrine organs (42%). Non-white males and females had respective values for excess esophageal cancer mortality of 42% and 22%. For stomach cancer mortality for non-whites the excesses were 86% and 33% respectively. The non-white male additionally had excesses for the sites of nasopharynx (203%), other skin (555%) and lymphosarcoma (906%). Non-white females showed excess cancer mortality for the sites of pancreas (201%), nose and middle ear* (175%), and brain and other nervous system cancers*(388%).

"Weighted Risk Ratios": The ratio of the rate in Order 1 counties to the sum of all the weighted rates for esophageal cancer mortality was 1.30 for white males and 1.27 for white females. White males demonstrated elevated risks in the first Order counties for the sites of stomach (1.27), larynx (1.25), and thyroid (1.20). A risk ratio of 1.38 was noted for white female mortality from cancer of the endocrine organs. Non-white males had elevated risk ratios for the sites of nasopharynx (2.50), "other" skin*(3.39), and lymphosarcoma (4.10). The sites of nose and middle ear* and brain and other nervous system* had weighted risk ratios of 2.18 and 3.42, respectively, for non-white females.

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* See the NIH publication (80) for a complete listing of cancers included in this category.

The "weighted risk" ratios comparing site rates in Order 2 to the sum of all the weighted rates showed minimal differences from "1.0" for white males and females. The largest departure from "1.0" was 1.30 for white male thyroid cancer mortality. Non-white males had risk ratios of 4.03 for breast cancer mortality, 2.7 for mortality due to eye cancer, 3.4 for bone cancer mortality and 3.24 for mortality due to Hodgkin's disease. Non-white females had elevated risk ratios for the sites of salivary glands (2.00) and esophagus (6.19).

The ratios of site rates in Order 3 counties to the sum of all the weighted rates for white populations of the Great Lakes states did not differ markedly from unity. However, a 26% excess in non-white males and a 25% excess in non-white females was noted for tongue and mouth* cancer mortality. A 36% excess was also shown for thyroid gland cancer mortality for non-white males.

The populations living in the Great Lakes basin would be expected to experience varying degrees of exposure to lake contaminants. Exposure potentials are based upon many factors including occupational exposure, drinking water sources, landfill contamination, contamination of ambient air, and dietary habits. Those individuals who may be exposed to contaminants at levels which may produce disease may comprise a small subset of the entire population. Therefore, the excess cancer mortality contributed by the "high risk" groups may not dramatically increase the mortality rates in one Order of counties over those of another Order. All average rates were examined by site for evidence of increasing or decreasing mortality by relative geographic proximity to the Great Lakes. Tables 18and19 demonstrate increasing average mortality rates with increased proximity to the Great Lakes for the "urban and rural" and "rural" analysis respectively.

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* See the NIH publication (80) for a complete listing of cancers included in this category.

Tables 20 and 21 list by race and sex those cancer sites which have average cancer mortality rates which decrease in magnitude as one approaches the Great Lakes. In summary, twenty-nine race and sex specific sites were shown to have increased with proximity to the Great Lakes and twenty decreased in the "urban and rural" analysis. In the "rural" analysis, twenty-seven sites increased and twenty-three decreased with proximity to the Great Lakes.

D. Discussion

In the "urban and rural" analysis comparing Order 1 counties to those of the other Orders, white males experienced the highest mortality from esophageal, stomach, breast, and thyroid cancers when examining the weighted and unweighted risk ratios. The demonstration of excess mortality in these sites for first Order counties was consistent with the "rural" analysis. White females had the greatest excess mortality for cancers of the esophagus, stomach, and endocrine organs* in the "urban and rural" analysis in Order 1 counties. This pattern was also found in the "rural" analysis. The excesses in rates noted for the first Order county white population were typically between 25% and 50% over those of the other Order counties. A "risk" ratio of two or greater was not found in the thirty-five sites examined.

The non-white populations of the Great Lakes basin demonstrated elevated risks for many sites in Order 1 counties. For example, non-white females had a risk ratio of 10.06 for lymphosarcoma when comparing Order 1

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* See the NIH publication (80) for a complete listing of cancers included in this category.

TABLE 18

Cancer Sites Demonstrating INCREASING Average Mortality Rates With Proximity to the Great Lakes Basin

Site	Race	Sex
Lip	NW	F
Nasopharynx	W	F
Tongue, Mouth	W	M
	W	F
Esophagus	W	M
	W	F
Stomach	W	M
	W	F
	NW	M
Large intestine	W	M
Liver	NW	M
	NW	F
Pancreas	W	M
	W	F
Nose, Middle ear	NW	F
Larynx	W	M
Trachea, Bronchus, Lung	W	M
Breast	W	F
Corpus uteri	NW	F
Bladder	W	F
Other skin	NW	M
Endocrine organs	W	M
Lymphosarcoma	W	M
	W	F
	NW	M
Multiple myeloma	W	F
Malignant neoplasms	W	M
	W	F
	NW	M

TABLE 19

Rural Analysis - Omitting Counties With Population Centers $\geq$100,000

Cancer Sites Demonstrating INCREASING Average Mortality Rates With Proximity to the Great Lakes Basin

Site	Race	Sex
Nasopharynx	W	F
Tongue, Mouth	W	M
	W	F
Esophagus	W	M
	W	F
Stomach	W	M
	W	F
	NW	M
Large intestine	W	M
Pancreas	W	M
	W	F
Larynx	W	M
Trachea, Bronchus, Lung	W	M
Breast	W	F
Corpus uteri	NW	F
Bladder	W	F
Other skin	NW	M
Endocrine organs	W	M
Lymphosarcoma	W	M
	NW	M
All neoplasms	W	M
	W	F
	NW	M
Liver	NW	M
	NW	F
Nose, Middle ear	NW	M
	NW	F

TABLE 20

Cancer Sites Demonstrating DECREASING Average Mortality Rates With Proximity to the Great Lakes Basin

Site	Race	Sex
Lip	W	F
Tongue, Mouth	NW	M
	NW	F
Pancreas	NW	M
Trachea, Bronchus, Lung	W	F
Corpus uteri	W	F
Ovary, Fallopian tube	NW	F
Kidney	NW	F
Bladder	NW	F
Skin melanoma	W	M
	W	F
Other skin	W	M
	W	F
	NW	F
Eye	W	M
Bone	W	F
	NW	F
Hodgkin's Disease	W	F
Leukemia	W	M
	W	F

TABLE 21

Rural Analysis - Omitting Counties With Population centers 100,000

Cancer Sites Demonstrating DECREASING Average Mortality Rates With Proximity to the Great Lakes Basin

Site	Race	Sex
Lip	W	F
Tongue, Mouth	NW	M
	NW	F
Large intestine	W	F
Pancreas	NW	M
Larynx	NW	F
Trachea, Bronchus, Lung	W	F
Corpus uteri	W	F
Bladder	NW	F
Skin melanoma	NW	M
	W	M
	W	F
Other skin	W	M
	W	F
	NW	F
Eye	W	M
Bone	W	F
	NW	F
Leukemia	W	M
	W	F
Ovary, Fallopian tubes	NW	F
Kidney	NW	F
Hodgkin's disease	W	F

counties with the Order 3 counties in the rural analysis. The Order 1 county average rate was based on twenty-five reported deaths over the twenty year period. The point of the example is that many of the extreme rates reported here for non-whites are based on very small numbers of reported deaths. Each ratio reported in Appendix I should be evaluated independently by a critical review of both the numerator and denominator data. The accuracy and consistency of the reporting of cancer deaths in the non-white populations between 1950 and 1969 (93) are subject to question. Conclusions drawn from the non-white ratios would be highly speculative at best. The reader is cautioned since incidence, as opposed to mortality, data are typically evaluated in studies of disease etiology.

In conclusion, the fifth analysis supports prior analyses which indicate that white populations in first Order counties experienced a higher rate of mortality due to esophageal and stomach cancers than in second and/or third Order counties. These excesses remained when large urban centers with their possible confounding factors were removed from the analysis. Furthermore, these disparities persisted when a second analysis was performed which weighted each rate by the respective population count. Excess mortality due to cancers of the breast in white males and endocrine organs* in white females in first Order counties were also noted in this analysis.

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* See the NIH data set (80) for a complete listing of cancers included in this category.

A Pilot Study to Determine the Feasibility of an Epidemiologic Investigation Among Commercial Fishermen of the Effects of Polychlorinated Biphenyls on Health

I. Background and Rationale

A critical concern with respect to the presence of polychlorinated biphenyls (PCBs) in the environment is the introduction of these compounds into the human food chain. However, there is limited information regarding PCB exposure to the general population via food consumption. Jelink and Corneliussen report that for the period between 1969 and 1975, there have been significant decreases in the PCB levels in all food commodities with the exception of fish (60). Data from the U.S. Fish and Wildlife Service (U.S.F.W.S.) regarding PCB concentrations in fish species sampled from the Great Lakes indicate that the average PCB concentrations for several fish species exceed recommended F.D.A. levels* for human consumption. Average PCB concentrations were noticeably higher in fish species taken from Lake Michigan than those taken from other lakes. It must be noted however, that these averages are based upon small sample sizes and no trends could be established from year to year.

Graham reported on the levels of PCB in the edible portion of commercial fish species from the Canadian waters of the Great Lakes. His results indicate that several commercial species have mean PCB concentrations greater than 1 ppm. Table 22 summarizes his findings.

* Current F.D.A. tolerance levels for PCBs in fish = 5 ppm

Recommended F.D.A. tolerance levels for PCBs in fish = 2 ppm

TABLE 22

Levels of PCBs in Canadian Fish Species

Lake	Fish Species	Mean PCB Concentration (ppm)
Superior	lake herring	1.17
	lake trout	2.02
Huron	chub	2.09
	carp	1.55
	sucker	1.33
	coho salmon	5.11
Erie	alewife	1.22
	carp	1.27
	yellow pickerel	1.16
	white bass	1.26
	catfish	2.04
	coho salmon	3.14
Ontario	yellow perch	1.23
	smelt	4.16
	white perch	1.84
	carp	1.69
	rock bass	1.76
	eel	17.14
	coho salmon	4.97

Graham, J.M. "Levels of PCBs in Canadian Fish Species." in: National Conference on Polychlorinated Biphenyls, November 17-21, Chicago, Illinois. E.P.A. 560/6-75-004, March 1976.

The State of Michigan has collected data regarding PCB concentrations in fish taken from Lake Superior. Results indicate that lake trout have the greatest PCB body burdens and exceed recommended F.D.A. levels in many instances. It is interesting to note that the sampling stations used to collect Lake Superior fish species are adjacent to counties in the upper peninsula of Michigan which are relatively free of industries normally associated with PCB discharges. This suggests several possible explanations including:

1) Fish may spend part of their life cycle in highly polluted waters and then migrate to other portions of the lake.
2) Non-point sources of PCBs (e.g., atmosphere, water column, bottom sediments) have a much greater impact on fish body burdens than previously expected.
3) There are unidentified sources of PCBs resulting in increased exposure to fish in these areas.
4) Fish taken from waters adjacent to heavily industrial areas may have much greater PCB body burdens.

The Region V office of the U.S.E.P.A. is currently evaluating data regarding PCB levels in fish taken from Lake Michigan. Preliminary results indicate the fish from southern Lake Michigan have greater PCB concentrations than those from northern Lake Michigan. This is not surprising due to the magnitude of industrialization around southern Lake Michigan waters.

Humphrey and his associates measured the PCB levels in persons consuming sport fish caught from Lake Michigan. These authors conclude that there could be long-term accumulation of PCBs in individuals consuming large amounts of fish (52). However, at the time of their studies, no differences in health status could be observed between participants (i.e., fish consumers) and controls. This does not negate the possibility of latent effects resulting from chronic exposure which might be demonstrated at a later date.

In summary, it appears that the scope of PCB contamination of the food supply has narrowed to the point where fresh water fish are the primary source of PCB exposure in the diet of fish-consuming individuals. According to Jelink and Corneliussen the average daily dietary intake of fresh water fish of the U.S. citizen is low (60). However, their reports do not consider population sub-groups which may consume significantly larger quantities of fish than the general population and, therefore, may have a potentially greater exposure to PCBs.

II. Aims and Objectives

A. General

The intent of this pilot study was to evaluate three research protocols to determine the effectiveness and feasibility of an epidemiologic investigation of commercial fishermen. Several issues were addressed, including:

1. Could the requisite study participants be found?
2. Would the participants respond to the study instruments (i.e., questionnaires?)
3. Would one test protocol produce better responses than another?
4. Is the information obtained from the study instruments accurate?
5. Could verification of the participant responses be obtained?
6. What is the distribution of fish consumption (both amount and type) in this cohort?

III. Methods

A. Study Protocols

Three detailed protocols were developed for the collection of information regarding the fishing practices and health status of commercial fishermen. These included a telephone-survey protocol (Protocol I), a protocol involving a pre-mailing of a set of questions with a subsequent telephone-survey (Protocol II), and a mailing of a questionnaire protocol (Protocol III).

These protocols were tested using questionnaires and study correspondence developed by the Great Lakes project staff. Protocol effectiveness was determined by evaluating which method:

1. Produced the greatest proportion of questions answered in the correct format.
2. Produced the greatest participation rate.
3. Produced the most reliable responses as determined through validation.

B. Identification and Selection of a Study Population

Since the purpose of this study was to identify a population in the Great Lakes basin with potentially high PCB exposure and determine the feasibility of an epidemiologic investigation of that "high risk" population, several possible study populations were identified including sport fishermen, commercial fishermen, and sub-samples of the general population from areas contaminated with PCBs or other organics. Based on the availability of licensing records and the recognition of the problems associated with determining PCB exposure in the general population, commercial fishermen were selected as the initial study population.

Available commercial fishing licenses were requested fron the states of Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York. In addition to the state listings other sources included commercial fishing organizations and publication membership lists which were especially useful in identifying retired commercial fishermen. In general, the most frequently contacted sources of information were the respective state licensing departments. Table 23 illustrates the kinds of information obtained from each state regarding licensed commercial fishermen.

A potential problem with the use of current lists of commercial fishermen is the omission of individuals who fish intermittently and purchase licenses on a less than yearly basis (as compared with a full-time fisherman who purchases a license every year) and recent retirees. State departments were willing to send current lists of commercial fishermen but expressed concern over the feasibility of abstracting past records. Great Lakes study members visited the Departments of Natural Resources in the states of Indiana and Wisconsin to evaluate the content of commercial fishing records.

TABLE 23

Sources of Information Regarding Commercial Fishermen

State	Sources of information regarding commercial fishermen	Number of individuals with licenses
New York	1. New York State Department of Environmental Conservation	
	a) 1980 list of commercial fishermen--Lake Erie	25
	--Lake Ontario	25
Illinois	2. State Department of Natural Resources	
	a) 1980 list of commercial fishermen--inland waters	382
Indiana	1. State Department of Natural Resources	
	a) 1975-1981 list of commercial fishermen--Lake Michigan	66
	b) 1980 list of commercial fishermen--inland waters	239
Pennsylvania	1. Pennsylvania Fish Commission Division of Fisheries	
	a) 1979 list of commercial fishermen--Lake Erie	42
Minnesota	1. Department of Natural Resources	
	a) 1979 list of commercial fishermen--Lake Superior	89
	2. Claude Ver Duin, Editor of The Fisherman	
	a) Publication list of former commercial fishermen (retired?)	25
Ohio	1. Department of Natural Resources	
	a) 1980 list of commercial fishermen--Lake Erie	134
Michigan	1. Department of Natural Resources	
	a) 1980 list of commercial fishermen--Lakes Michigan, Huron, Superior	
	2. Claude Ver Duin, Editor of The Fisherman	
	a) Publication listing of commercial fishermen	170
Wisconsin	1. Department of Natural Resources	
	a) 1974, 1976-1981 list of commercial fishermen in Lakes Superior, Michigan	449
	total	1,646
	less - Inland Waters	621
	Great Lakes	1,025

Compiled by the Great Lakes Project Staff

An additional 58 individuals or 90% of the state cohort were abstracted from Indiana files and 202 individuals or 45% of the state cohort were abstracted from Wisconsin files. These results suggest that current license holders do not accurately reflect the number of individuals who have commercially fished in the recent past and that all state licensing departments should be contacted in person to abstract all available records. In general, license records are maintained from 3 to 5 years. However, some states (e.g., Wisconsin) maintain records for up to twenty years.

For the purposes of the pilot study it was decided that the individuals obtained from the various information sources mentioned in Table 23 were sufficient to test study protocols and instruments.

A total of 1,025 individuals were identified as licensed Great Lakes commercial fishermen between the years 1974 to 1981. The majority of commercial fishermen are found in the state of Wisconsin and fish Lake Michigan. In addition to the Great Lakes commercial fishermen, there were large contingents of inland commercial fishermen (i.e., individuals who fish non-Great Lake associated rivers and lakes in the states of Illinois and Indiana). These individuals totaled 621 but were not included in the pilot study. The reasoning behind this omission stemmed from the fact that their socio-economic status and racial composition may be significantly different from that of Great Lakes commercial fishermen. It was reported that a significant number of these individuals are black and the majority come from a low socio-economic background. However, their incorporation into a large-scale study should be considered, possibly with separate analytical procedures.

The study protocols and instruments were pilot tested using a randomly selected sub-sample (n = 75) of Great Lakes commercial fishermen. Individuals were stratified according to lake and state. The number of individuals to be used in the pilot study from each lake/state stratum was arbitrarily selected to insure

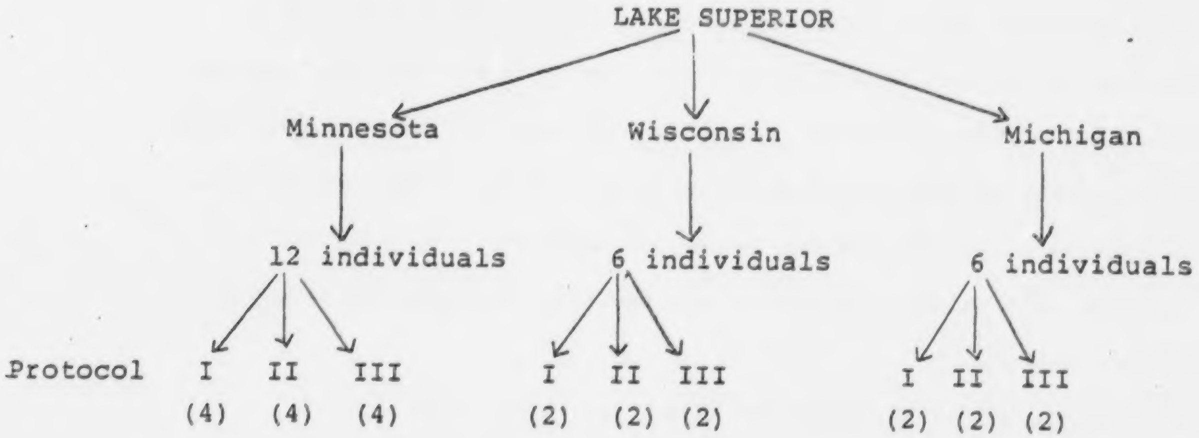
TABLE 24

Number of Commercial Fishermen in the Great Lakes Basin by Lake and State

Lake	States adjacent to the lake	Number of fishermen from each state who fish the lake	Number of fishermen randomly selected by state	Total number of fishermen to be studied by lake
Superior	Minnesota	114	12	24
	Wisconsin	44	6	
	Michigan	25	6	
Michigan	Wisconsin	424	12	24
	Michigan	76	6	
	Indiana	66	6	
	Illinois	0	0	
Huron	Michigan	47	9	9
Erie	Ohio	134	6	12
	Pennsylvania	42	3	
	New York	25	3	
	Michigan	3	0	
Ontario	New York	25	6	6
Totals		1,025	75	75

a representative sample of commercial fishermen from the entire Great Lakes Basin region. Table 24 describes the number of individuals available by lake and state. Included in this table is an arbitrary number of randomly-selected individuals to be used in the pilot study.

The sub-sample of Great Lakes commercial fishermen was divided and randomly assigned to each of three study protocols with an equal distribution of individuals among each protocol. The number of individuals assigned to each protocol was dependent on the number of individuals arbitrarily selected from each state. The following diagram illustrates this procedure for Lake Superior as an example:


LAKE SUPERIOR
Minnesota
Wisconsin
Michigan
12 individuals
6 individuals
6 individuals
Protocol
I
II
III
(4)
(4)
(4)
I
II
III
(2)
(2)
(2)
I
II
III
(2)
(2)
(2)

A similar procedure was used for each lake resulting in a total of 25 individuals selected per protocol for the purpose of the pilot study. The majority of fishermen selected in this manner came from the states of Minnesota, Wisconsin, and Michigan. There were no individuals from the state of Illinois since available records indicated that these individuals were inland commercial fishermen.

C. Questionnaire

The questionnaire developed for this pilot project was designed to assess the fish consumption practices, behavioral patterns, and health status of commercial fishermen and their families. There were two forms of this questionnaire; one for the mailed questionnaire format (Protocol III), and one for the telephone survey (Protocol I) and the telephone survey with a pre-mailed set of questions (Protocol II). In addition, the questions were modified for a proxy interview. There were no major differences among these questionnaires. In some instances the sentence structure has been rearranged to accomodate slight differences in subject approach. (See Appendix II).

Specific information requested from commercial fishermen included the following topics:

1. Demographic characteristics (i.e., age, race, sex)
2. Occupational histories
3. The fishing practices and consumption patterns of study participants and their family members
4. The smoking histories of study participants (i.e., cigarette, cigar, and pipe usage)
5. The drinking histories of study participants (i.e., liquor, wine, and beer usage) .

6. The prevalence of selected diseases among study participants and their family members
7. The pregnancy histories of female participants and the wives of male participants
8. The prevalence of birth defects among family members of study participants
9. A participant check list of symptoms relevant to PCB exposure (and other organic chemicals e.g., prior exposure to DDT)
10. The menstrual histories of female participants and the wives of males participants

D. Protocol I Procedure

Twenty-five subjects were randomly allocated to Protocol I by the procedures described in the preceding section. A file folder was made for each individual and labeled with the individual's name, address, telephone number, and protocol number. Materials mailed to each subject included an introductory letter, a medical consent form, and a stamped,return-addressed envelope to return the consent form. (see Appendix III).

To facilitate telephone interview scheduling, these materials were mailed to five different subjects per day so that by the end of a five-day period all twenty-five subjects had been mailed a Protocol I packet. Subjects were telephoned seven days after the individual mailing dates of the study materials (see Section G).

In the event that the materials packet was returned to the University because the subject was deceased or the address was incorrect, attempts were made to 1) locate an appropriate proxy for an interview and retrieve the death certificate for the original subject or 2) obtain the correct address for the subject and request an interview. If these procedures failed, the subject was considered lost to follow-up and his/her folder was placed in the "complete" file.

At the time of subject contact it was determined whether or not the individual wished to participate in the study. The outcomes regarding subject participation included:

1) Subject could not be interviewed at the time of the call.
2) Subject was deceased.
3) Subject refused to participate in the study.
4) Subject agreed to be interviewed at the time of the call.

If the time of the call was inconvenient for the subject a date and time was established for a return call and the subject's folder was placed in the "pending" file with the corresponding date for retrieval.

If the subject was deceased, it was determined whether or not the contacted individual was appropriate for a proxy interview. If the contacted individual was appropriate as a proxy, an interview was requested. If the proxy subject refused, additional next of kin were contacted for a proxy interview. If no next of kin were available as proxies, the subject's folder was labeled "complete without an interview" and a request for a death certificate was sent to the appropriate state vital statistics office.

If the subject refused to be interviewed his/her folder was placed in an "initial refusal" file for a three-week waiting period. Following this period the subject was called again and asked to participate in the study. If the subject refused a second request,his/her folder was placed in the "complete" file as a refusal.

If the subject agreed to an interview either on the initial or second request the subject was interviewed. Following completion of the interview the subject was asked to sign and return the medical consent form. If the consent form was not returned within a period of ten days, a second letter requesting the signed medical consent form was mailed to the subject. If the consent form was not returned after another ten day period the subject was called to elicit his/her cooperation in returning the consent form. All efforts were made to obtain the signed medical consent form for study participants; however, in those instances where these attempts were unsuccessful, the subject's folder was placed in the "complete" file under the "no validation" category.

Upon completion of the interview and acquisition of a signed medical consent form, the study subject's folder was turned over to the validation section for the purpose of verifying the participant's medical history. A detailed flow-chart regarding Protocol I procedures appears in Figure 3

E. Protocol II Procedures

Protocol II follows a similar format to that of Protocol I (see Figure 3), the only difference being the contents of the mailed packet for Protocol II which consisted of an introductory letter, a stamped, return-addressed envelope, a medical consent form, and, in addition, a list of questions regarding fish consumption practices, behavioral patterns, and general health (see Appendix V). Furthermore, the mailing of this packet was completed during the week of telephone contact and interviewing for Protocol I. This scheduling system prevented the development of an interview backlog and facilitated the completion of both protocols (see Section G).

F. Protocol III Procedures

Twenty-five subjects were randomly allocated to Protocol III by the procedures described in an earlier section. A file folder was made for each individual and labeled with the individual's name, address, telephone number, and protocol number. A packet consisting of an introductory letter, a medical

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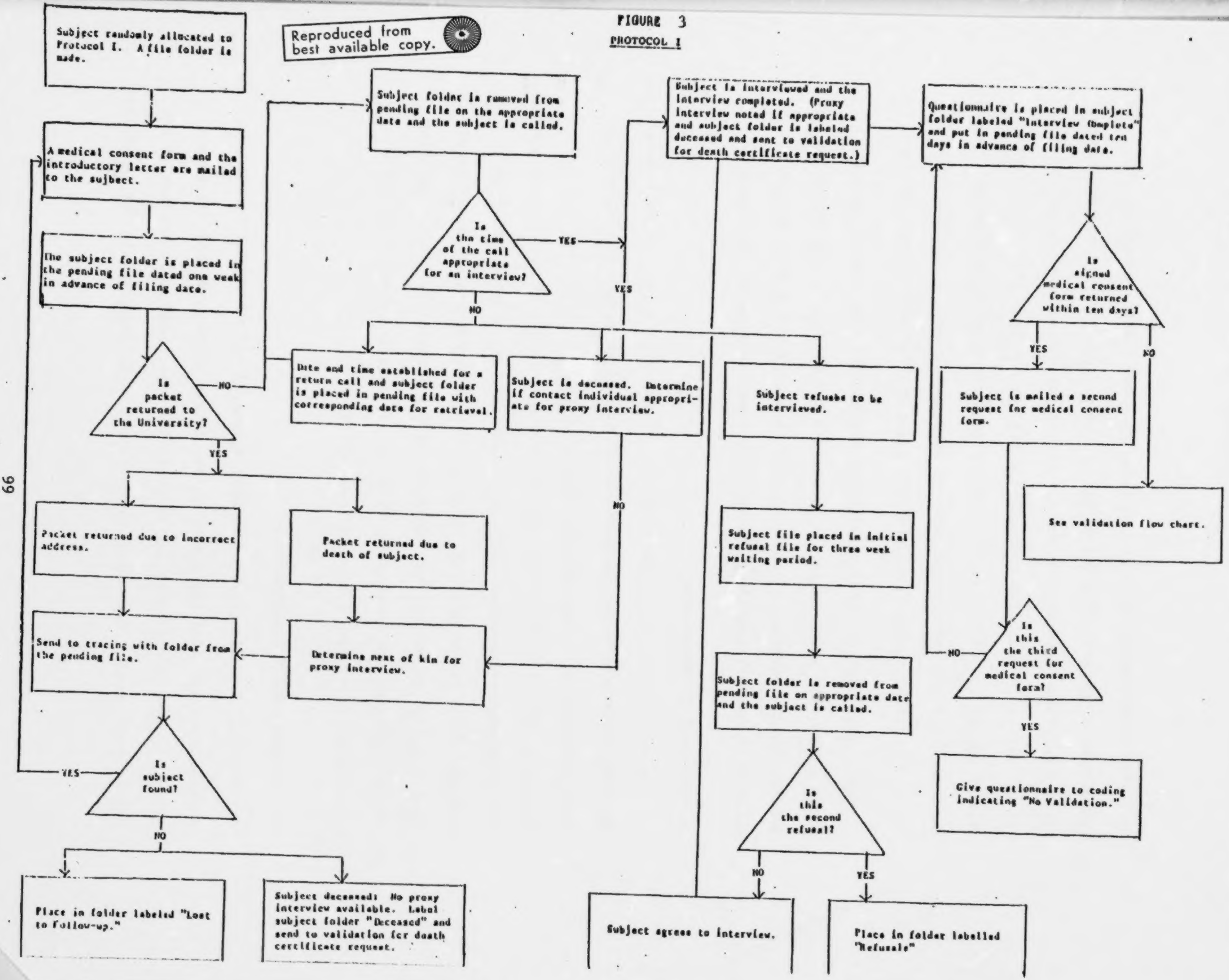
FIGURE 3

PROTOCOL I


Subject randomly allocated to Protocol I. A file folder is made.
A medical consent form and the introductory letter are mailed to the subject.
The subject folder is placed in the pending file dated one week in advance of filing date.
Is packet returned to the University?
NO
YES
Packet returned due to incorrect address.
Packet returned due to death of subject.
Send to tracing with folder from the pending file.
Determine next of kin for proxy interview.
Is subject found?
YES
NO
Place in folder labeled "Lost to Follow-up."
Subject deceased: No proxy interview available. Label subject folder "Deceased" and send to validation for death certificate request.
Subject folder is removed from pending file on the appropriate date and the subject is called.
Is the time of the call appropriate for an interview?
YES
NO
Date and time established for a return call and subject folder is placed in pending file with corresponding date for retrieval.
Subject is deceased. Determine if contact individual appropriate for proxy interview.
YES
NO
Subject refuses to be interviewed.
Subject file placed in initial refusal file for three week waiting period.
Subject folder is removed from pending file on appropriate date and the subject is called.
Is this the second refusal?
NO
YES
Subject agrees to interview.
Place in folder labelled "Refusals"
Subject is interviewed and the interview completed. (Proxy interview noted if appropriate and subject folder is labeled deceased and sent to validation for death certificate request.)
Questionnaire is placed in subject folder labeled "Interview Complete" and put in pending file dated ten days in advance of filing date.
Is signed medical consent form returned within ten days?
YES
NO
Subject is mailed a second request for medical consent form.
See validation flow chart.
Is this the third request for medical consent form?
NO
YES
Give questionnaire to coding indicating "No Validation."

consent form, a stamped, return-addressed envelope, and a questionnaire was mailed to the subject (see Appendix III).

In the event that the correspondence packet was returned to the University because the subject was deceased or the address was incorrect, attempts were made to 1) locate an appropriate proxy for an interview and to retrieve the death certificate for the original subject or 2) obtain the correct address for the subject and mail the individual a Protocol III packet. If these procedures failed, the subject was considered lost to follow-up and his/her folder was placed in the "complete" file.

One month following the initial mailing, those individuals who had not responded received a second Protocol III packet. Individuals not responding to the second mailing were considered refusals and their folder was placed in the "complete" file in the refusal category.

Study subjects responding to the initial or second request for participation were screened to determine if they had returned their medical consent forms with the questionnaires. Those individuals who failed to return their consent forms were mailed a second request for the medical consent form. In those instances where these attempts were unsuccessful, the subject's folder was placed in the "complete" file under the "no validation" category.

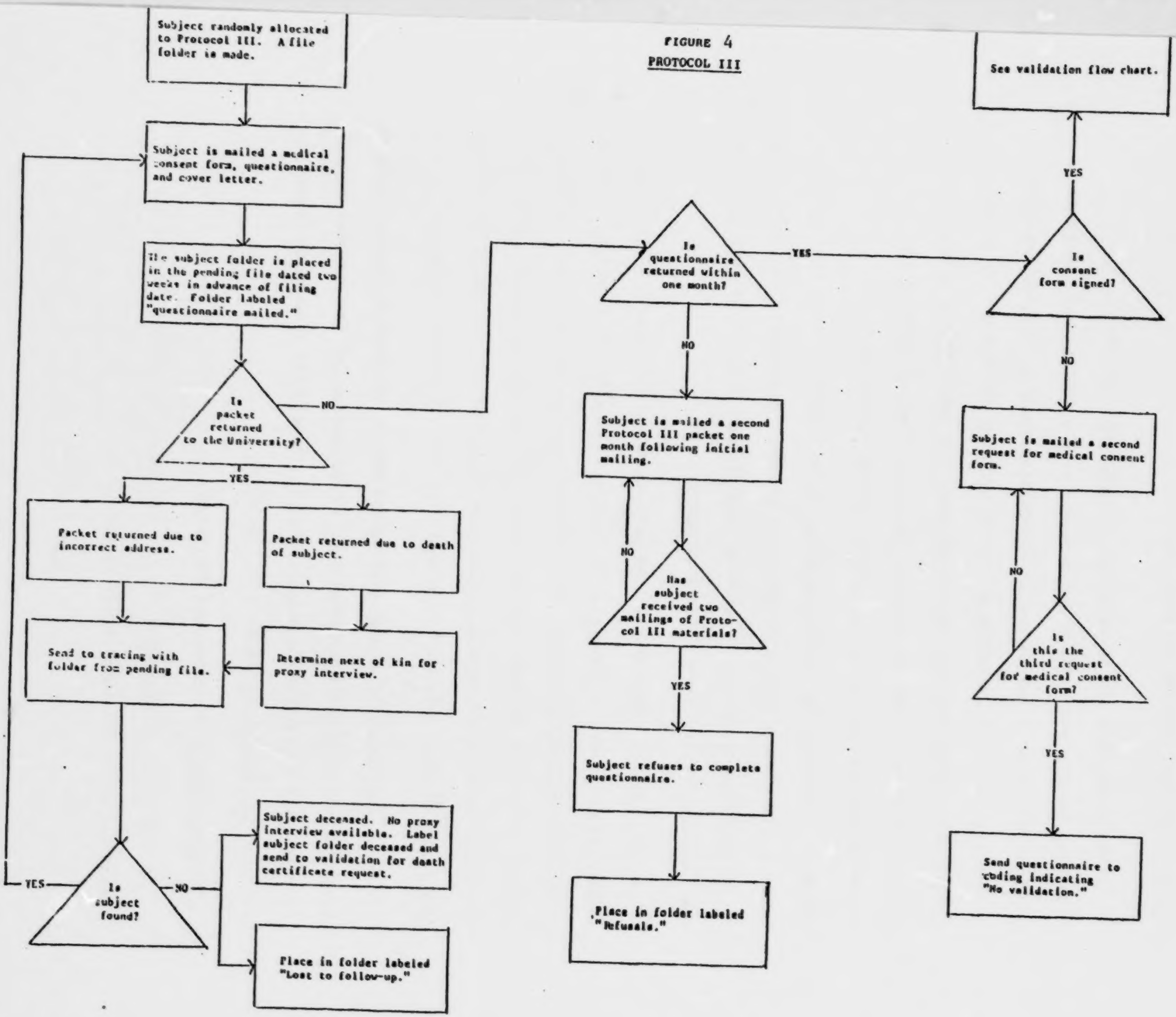
Upon acquisition of a completed questionnaire and medical consent form the study subject's folder was turned over to validation for the purposes of verifying the participant's medical history. A detailed flow-chart regarding Protocol III procedures appears in Figure 4.

G. Timetable for Pilot Project Initiation

A timetable was developed for the initiation of subject contact and interviewing for all three study protocols.

FIGURE 4

PROTOCOL III


Subject randomly allocated to Protocol III. A file folder is made.
Subject is mailed a medical consent form, questionnaire, and cover letter.
The subject folder is placed in the pending file dated two weeks in advance of filing date. Folder labeled "questionnaire mailed."
Is packet returned to the University?
NO
YES
Packet returned due to incorrect address.
Packet returned due to death of subject.
Send to tracing with folder from pending file.
Determine next of kin for proxy interview.
Is subject found?
YES
NO
Subject deceased. No proxy interview available. Label subject folder deceased and send to validation for death certificate request.
Place in folder labeled "Lost to follow-up."
Is questionnaire returned within one month?
YES
NO
Subject is mailed a second Protocol III packet one month following initial mailing.
NO
Has subject received two mailings of Protocol III materials?
YES
Subject refuses to complete questionnaire.
Place in folder labeled "Refusals."
See validation flow chart.
YES
Is consent form signed?
NO
Subject is mailed a second request for medical consent form.
NO
Is this the third request for medical consent form?
YES
Send questionnaire to coding indicating "No validation."

The initial mailing of Protocol III materials took place during the week of June 1 to 5, 1981. Materials for five of the twenty-five subjects were mailed each business day. All twenty-five subjects were mailed materials by the end of the five-day period. After a period of one month, those subjects not returning their materials were sent a second Protocol III packet during the period June 29 to July 3, 1981.

The initial mailing of Protocol I materials took place during the period June 8 to 12, 1981. Materials for five of the twenty-five subjects were mailed each business day. All twenty-five subjects were mailed materials by the end of the five day period. The corresponding phone contacts and interviews took place seven days following the dates of mailing of Protocol I materials for each subject. The contacts and interviews were begun on the respective days of June 15 to 19, 1981.

The procedure for Protocol II was similar to that of Protocol I with the mailing of Protocol II materials occurring during the period June 15 to 19, 1981 and the contact and interviewing via telephone occurring seven days following the mailings of Protocol II materials to each study subject. The schedule in Figure 5 outlines the implementation of the pilot project.

H. Validation Procedures

Following completion of the interview and the acquisition of the signed consent form the subject's folder was sent to the validation section for purposes of verifying the medical history of the study participant.

A validation form (see Appendix III) was completed for each subject and contained information regarding the name, address, and phone number of the study participant, the name,address,and phone number of the medical sources, the date and reason for contacting medical sources, and a calendar noting the dates

FIGURE 5

PROTOCOL IMPLEMENTATION

Week of June 1 to June 5

Initiate Protocol III (Mailed Questionnaire)

Mail materials to:	6/1/81 Monday 5 subjects	6/2/81 Tuesday 5 subjects	6/3/81 Wednesday 5 subjects	6/4/81 Thursday 5 subjects	6/5/81 Friday 5 subjects

Subject folder placed in pending file for one month

Week of June 8 to June 12

Initiate Protocol I (Telephone Interview)

Mail materials to:	6/8/81 Monday 5 subjects	6/9/81 Tuesday 5 subjects	6/10/81 Wednesday 5 subjects	6/11/81 Thursday 5 subjects	6/12/81 Friday 5 subjects

Week of June 15 to June 19

Begin telephone interviews for Protocol I
Initiate Protocol II

6/15/81 Monday *5 participants #5 subjects	6/16/81 Tuesday 5 participants 5 subjects	6/17/81 Wednesday 5 participants 5 subjects	6/18/81 Thursday 5 participants 5 subjects	6/19/81 Friday 5 participants 5 subjects

Week of June 22 to June 26

Complete telephone interviews of Protocol I participants
Begin telephone interviews of Protocol II participants using similar procedures as outlined above

Week of June 29 to July 3

Begin status check on Protocol III participants and initiate second mailing for those individuals failing to respond to the first request
Complete telephone interviews of Protocol I participants failing to interview in the preceeding week
Complete telephone interviews of Protocol II participants

*Telephone Interview of Protocol I Subjects
#Mail Introductory Packages to Protocol II Subjects

and status of request/acquisition of medical records.

A request for medical records, a photocopy of the medical consent form, and an abstract form were mailed to all medical sources named by the study participant (see Appendix III). The subject's folder was placed in the validation file dated two weeks in advance of the filing date. If the medical records were not received after a two week period, a second request for medical records was initiated. After three non-responses via the postal system, medical sources were contacted by phone to obtain their cooperation. If these methods failed to validate study participant's medical histories, his/her folder was placed in the "complete" file with the validation complications noted for coding and data analysis.

In instances where the study subject was deceased, a death certificate request letter and abstract form were sent to the appropriate state vital statistics office. (see Appendix III). The subject's folder was placed in the validation file dated two weeks in advance of the filing date. If the death certificate was not received within a period of two weeks, a second request was initiated. After three non-responses from the state vital statistics office, the subject's folder was placed in the "complete" file and the unavailability of the death certificate was noted.

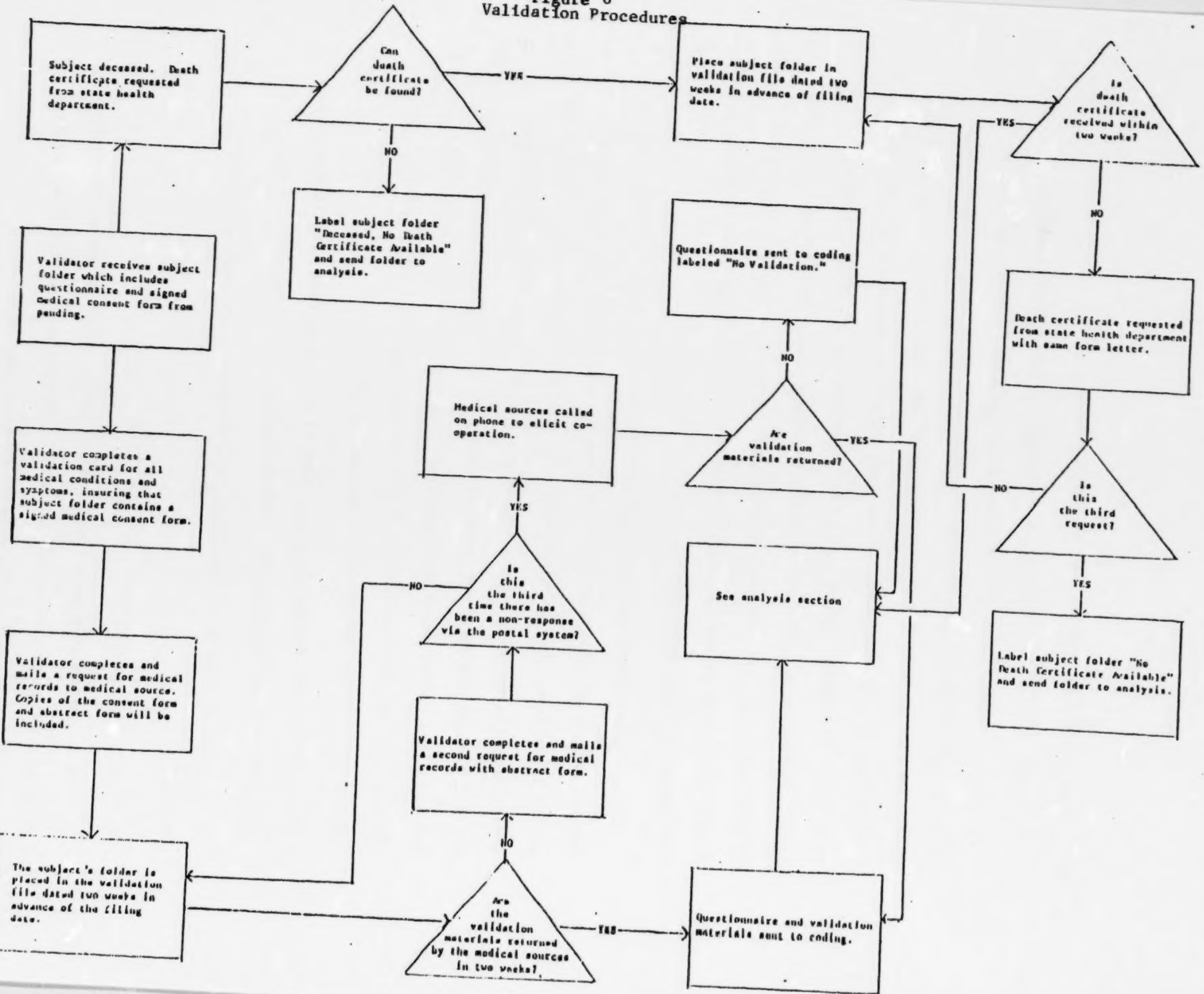
Following the successful acquisition of all validation materials medical histories will be verified and coded for analytical purposes.

A detailed flow-chart describing the validation procedures appears in Figure 6.

I. Tracing Procedures

Tracing procedures were intitiated in those instances where the study materials were returned to the University indicating that the study subject was no longer located at the address given on the license.

Figure 6
Validation Procedures



Subject deceased. Death certificate requested from state health department.
Can death certificate be found?
YES
NO
Label subject folder "Deceased, No Death Certificate Available" and send folder to analysis.
Place subject folder in validation file dated two weeks in advance of filing date.
Is death certificate received within two weeks?
YES
NO
Death certificate requested from state health department with same form letter.
Is this the third request?
NO
YES
Label subject folder "No Death Certificate Available" and send folder to analysis.
Validator receives subject folder which includes questionnaire and signed medical consent form from pending.
Validator completes a validation card for all medical conditions and symptoms, insuring that subject folder contains a signed medical consent form.
Validator completes and mails a request for medical records to medical source. Copies of the consent form and abstract form will be included.
The subject's folder is placed in the validation file dated two weeks in advance of the filing date.
Are the validation materials returned by the medical sources in two weeks?
YES
NO
Questionnaire and validation materials sent to coding.
Validator completes and mails a second request for medical records with abstract form.
Is this the third time there has been a non-response via the postal system?
NO
YES
Medical sources called on phone to elicit co-operation.
Are validation materials returned?
YES
NO
Questionnaire sent to coding labeled "No Validation."
See analysis section

Initial tracing procedures included the use of directory assistance, reverse directories (Polks and Coles), and the post office to inquire about prior addresses of the study subjects.

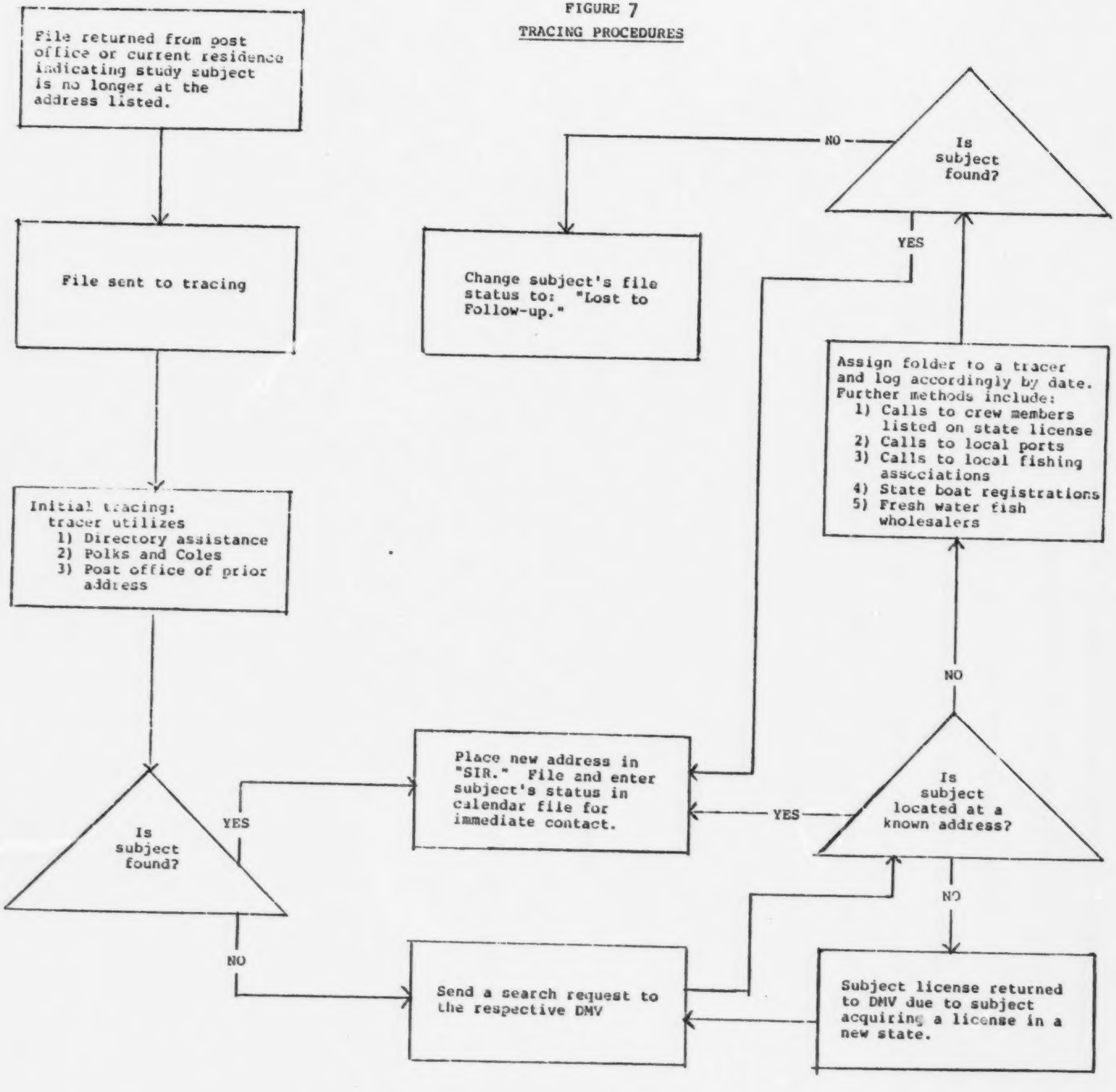
If these procedures failed to locate the subject, a search request to the state department of motor vehicles was initiated. This procedure either resulted in a known address for the subject or indicated that the subject did not hold a driver's license in that state.

Advanced tracing procedures included contacting crew members and other commercial fishermen, contacting local fishing ports, contacting commercial fishing organizations, requesting information regarding state boat registrations, and contacting Great Lakes fish wholesalers.

If these methods failed to locate the study subject, he/she was placed in the "complete" file noting that the individual was lost to follow-up. A detailed flow-chart of tracing procedures appears in Figure 7.

FIGURE 7

TRACING PROCEDURES


File returned from post office or current residence indicating study subject is no longer at the address listed.
File sent to tracing
Initial tracing: tracer utilizes 1) Directory assistance 2) Polks and Coles 3) Post office of prior address
Is subject found?
YES
NO
Place new address in "SIR." File and enter subject's status in calendar file for immediate contact.
Send a search request to the respective DMV
Is subject located at a known address?
YES
NO
NO
Subject license returned to DMV due to subject acquiring a license in a new state.
Assign folder to a tracer and log accordingly by date. Further methods include: 1) Calls to crew members listed on state license 2) Calls to local ports 3) Calls to local fishing associations 4) State boat registrations 5) Fresh water fish wholesalers
Is subject found?
YES
NO
Change subject's file status to: "Lost to Follow-up."

J. Coding

This section outlines the coding proposals for the Great Lakes pilot project questionnaire. Testing of the coding and data analysis proposals would involve the use of computer statistical packages to determine an efficient analytical procedure applicable to a large-scale study.

The general instructions regarding the Great Lakes pilot study coding proposal include:

1) placing a "9" in all coding spaces for a response of "dont know" (e.g., _9_ _9_ _9_).
2) placing an "8" in all coding spaces for a response of "refused to answer" or "not answered" (e.g., _8_ _8_ _8_).
3) placing a "0" in a coding space when an answer requires less coding space than allotted. The coding spaces to the left would be filled with zeros (e.g., three spaces provided and the answer given is 9 = _0_ _0_ _9_).

The proposed set of coding instructions for the pilot study questionnaire is presented in Appendix IV.

K. Data Analysis

This section outlines the data analysis proposal for the Great Lakes pilot project. This proposal in conjunction with the coding proposal outlined in the preceeding section should be tested prior to implementation of a large-scale study. Testing would involve the use of computer statistical packages to determine an efficient analytical procedure applicable to a large-scale study.

Participant demographics will be used to develop a descriptive profile of this occupational cohort. Fishing histories (i.e., the number of years fished and location where participant fished most often) will be evaluated in conjunction with reported fish consumption patterns to determine any discrepancies between these categories. That is, responses in one category can be used to verify the responses in the other. In addition, these responses will be used to determine the number of individuals with the greatest potential PCB/organic contaminant exposure. Based on the results of this evaluation, study subjects will be stratified into four exposure groups. High, moderate, low, and none. Individuals classified as "no exposure" will be used as an internal control group.

The information obtained from the survey regarding morbidity/mortality within these four categories of exposure will be used to determine frequencies. These frequencies will be used to calculate an odds ratio to determine potential health differences among the four exposure categories.

In addition, these analyses will be performed for family members (i.e., spouse and children) when their exposure (i.e., fish consumption patterns) are known to be similar to that of the study subject. Separate odds ratios will be calculated for study subjects in each exposure group to evaluate the potential confounding effects of smoking and drinking behavior on health.

The frequencies of birth defects and pregnancy complications among family members and spouses (wives) of the study participants will be evaluated. Exposure in these individuals will be based on two criteria including 1) the exposure category of the study subject and 2) the similarities of fish consumption practices between study subjects and their family members. These frequencies will be used to calculate an odds ratio to determine potential reproductive dysfunctions among the exposure categories.

Menstrual histories of female participants and the spouse of male participants were requested and these individuals will be stratified according to their potential exposure. Menstrual dysfunction frequencies will be calculated for each exposure category and used to calculate odds ratios.

The hypothesis that long histories of fish consumption (especially fish taken from areas of known environmental contamination) may increase PCB/organic contaminants exposure and result in demonstrable human health effects is not a realistic outcome of this pilot study. The purpose of the analytical section of this pilot study is to test the feasibility of these proposals. Appendix V contains a proposed set of analytical procedures and methods for the pilot study questionnaire.

IV. Pilot Study Results

A. Protocol I

The objective of the protocol I procedure was to evaluate the effectiveness of a telephone interview format among a cohort of commercial fishermen. A correspondence packet containing a medical consent form, an introductory letter, and a stamped, return-addressed envelope was mailed to the study subject. After seven days the subject was contacted by phone and and interview was requested. (see Section III-D).

Twenty individuals or 80% of the protocol I cohort were contacted by phone and eighteen or 90% of these individuals consented to an interview. Four subjects were never home at the time of the call and repeated efforts to contact these individuals failed. One subject had an unpublished phone number and efforts to contact this individual through the mail failed to elicit a response.

The current status of protocol I participants is summarized in Table 25. Of the eighteen or 72% of the total cohort who granted an interview, four have failed to return their signed medical consent form and one has refused to return the signed medical consent form. Efforts are continuing to 1) obtain the consent forms of the four subjects (29, 39, 45, and 46) who have not returned their signed consent form or 2) obtain a response indicating a refusal to cooperate with this aspect of the study procedure. Thirteen individuals or 52% of the total cohort are complete or partially complete for validation procedures.

The average time for an interview was approximately thirty-five minutes with a range of approximately twenty to fifty minutes. In addition, no study

TABLE 25

Status of Protocol I Participants

subject study number	subject status
26	interview complete - validation procedures are partially complete
27	interview complete - validation procedures are complete
28	subject not home at time of call
29	interview complete - signed consent form has not been returned
30	refusal
31	interview complete - validation procedures are complete
32	subject not home at time of call
33	interview complete - validation procedures are partially complete
34	interview complete - validation procedures are partially complete
35	interview complete - validation procedures are partially complete
36	subject not home at time of call
37	interview complete - validation procedures are complete
38	interview complete - validation procedures are complete
39	interview complete - signed consent form has not been returned
40	interview complete - validation procedures are partially complete
41	unpublished phone number
42	interview complete - validation procedures are partially complete
43	interview complete - validation procedures are partially complete
44	interview complete - validation procedures are partially complete
45	interview complete - signed consent form has not been returned for wife (subject divorced)
46	interview complete - signed consent form has not been returned
47	interview complete - subject refuses to return signed consent form
48	interview complete - validation procedures are complete
49	refusal
50	subject not home at time of call

materials were returned due to 1) an incorrect mailing address or 2) the death of the study participant. This suggests that information regarding commercial fishermen obtained from state files, publication lists, and fishing organizations was accurate with respect to address and reflected a living cohort.

Several problems were encountered with the telephone interview format including:

1) scheduling interviews with the study subject and spouse
2) subjects who were never at home at the time of call
3) subjects who were without a phone
4) subjects who had unlisted phone numbers

Despite these difficulties the addresses and living status were verified for all protocol I participants.

In those instances where interview times were difficult to obtain, either the subject or the spouse was requested to complete the entire interview. This situation occurred in three of the eighteen respondents. In one instance, the study subject completed the entire interview and in two instances the spouses of the study subject completed the entire interview. In eleven of eighteen respondents both the subject and spouse participated in the interview. Four of the eighteen respondents were living alone (i.e., single, widowed, separated/divorced) and the questions regarding reproductive histories and dysfunctions were not applicable.

In those instances where subjects did not have a phone or had an unlisted phone number, a letter was sent requesting their participation along with a card requesting a number where they could be reached. Of the two individuals which fit this category one responded and granted an interview.

Four study subjects were never home at the time of call despite consistent efforts to reach them. A possible explanation for their absence could be that they are living on their fishing vessel during the seasonal months. This suggests that a large scale study should be undertaken during the off-season when fishermen are more likely to spend time at their listed residence.

In general, the study subjects in protocol I responded well when asked to participate in the survey. There appeared to be no difficulties in interpreting the survey questions on the part of the study subjects with the exception of questions 149 and 150. These questions ask for the average length of the menstrual cycle and the average length of the "bleeding" period, and were consistently misinterpreted by respondents despite explanations by the interviewer. In addition, a potential problem may exist with the validity of question 26 regarding the pounds of fish consumed in a year. Many respondents hesitated when answering this question and needed to be coaxed into providing an answer. However, this answer will be cross-checked with the responses to questions 19 and 22 regarding the number of fish meals consumed per week or per month to provide a valid fish consumption index for data analysis purposes.

B. Protocol II

The objective of the protocol II procedure was to evaluate the effectiveness of a telephone interview preceded by a mailed set of questions identical to those asked during the telephone survey. A correspondence packet containing a letter of introduction, a medical consent form, a stamped, return-addressed envelope and a set of questions identical to those on the questionnaire was mailed to the study subject. After seven days the subject was contacted by phone and an interview was requested.(see Section III-E).

The purpose of the mailed set of questions identical to those asked in the interview was to evaluate whether this protocol produced more complete and valid responses on the part of the study subject given the fact that they would familiarize themselves with the questions prior to the interview.

Twenty-two individuals or 88% of the protocol II cohort were contacted by phone and 19 or 86% of these individuals consented to an interview. Two subjects had unpublished phone numbers and efforts to contact these individuals failed to elicit a response. One individual had recently moved to California and had not established a new residence at the time of this study.

The current status of protocol II participants is summarized in Table 26 Of the 19 or 76% of the total cohort who granted an interview five have failed to return their signed medical consent form and one has refused to return the signed medical consent form. Efforts are continuing to 1) obtain the consent forms of the five subjects (51, 57, 59, 63 and 75) who have not returned their signed consent forms or 2) obtain a response indicating a refusal to cooperate with this aspect of the study procedure. Twelve or 48% of the total cohort are complete or partially complete to validation procedures.

No study materials were returned due to 1) an incorrect mailing address or 2) the death of the study participant. In addition, the addresses and living status were verified for all protocol II subjects with the exception of subject 70 who was in transit to an out of state residence at the time of the study. In those instances where interview times were difficult to obtain, either the subject or their spouse was requested to complete the entire interview. This situation occurred in eight of the nineteen respondents. In five instances the subject completed the entire interview and in three instances the wife completed the entire interview. In seven of nineteen respondents both the subject and spouse participated in the interview. Three of nineteen respondents were single (i.e., never married) and the questions regarding reproductive histories and dysfunctions were not applicable. One respondent refused to let their spouse be interviewed, and as a result, no information was obtained regarding reproductive histories and dysfunctions for this subject.

TABLE 26

Status of Protocol II Participants

subject study number	subject status
51	interview complete - signed consent form has not been returned
52	interview complete - validation procedures are complete
53	interview complete - validation procedures are partially complete
54	interview complete - validation procedures are complete
55	refusal
56	interview complete - validation procedures are partially complete
57	interview complete - signed consent form has not been returned
58	refusal
59	interview complete - signed consent form has not been returned
60	refusal
61	interview complete - validation procedures are partially complete
62	unpublished phone number
63	interview complete - signed consent form has not been returned
64	interview complete - subject refuses to return signed consent form
65	unpublished phone number
66	interview complete - validation procedures are partially complete
67	interview complete - validation procedures are partially complete
68	interview complete - validation procedures are partially complete
69	interview complete - validation procedures are partially complete
70	directory assistance does not have a listing
71	interview complete - validation procedures are partially complete
72	interview complete - validation procedures are partially complete
73	interview complete - validation procedures are partially complete
74	interview complete - validation procedures are partially complete
75	interview complete - signed consent form has not been returned

The results and problems experienced in protocol II are similar to those experienced and discussed in protocol I. Methods used to remedy these problem areas were identical. The major difference between these protocols was the potential impact of the pre-mailed set of questions in protocol II which was to aid in the subject's development of responses prior to an interview on the telephone. The effectiveness of this protocol, as compared to protocol I, will be thoroughly evaluated following the completion of the validation procedures. However, several potential problem areas were identified including:

1) the number of questions was too large
2) the specificity of the questions may have been offensive to several participants
3) the study subjects did not use the set of questions for the purposes intended

In general, the study subjects in protocol II responded well to the survey questionnaire. In addition, family members (i.e., spouses) responded well when asked to participate in the survey. Similar problems with questions 26, 149, and 150 were encountered among the protocol II participants. Future application of this protocol to a cohort of commercial fishermen should consider modification of the pre-mailed set of questions. Both a reduction in the number of questions and the specificity of those questions appear warranted. However, the comparison of validation results for protocols I and II may alter this observation.

C. Protocol III

The objective of the protocol III procedure was to evaluate the effectiveness of a mailed questionnaire format among a cohort of commercial fishermen. A correspondence packet containing a medical consent form, a stamped, return-addressed envelope, an introductory letter, and a questionnaire was mailed to the subject. A second, identical packet was mailed in the event that the study materials were not returned following a one month time period. (see Section III-F).

Six individuals responded to the initial mailing for a response rate of 24%. Of these six individuals, one failed to return the signed medical records request form.

An additional five individuals or 20% responded to the second mailing. Of these five individuals one returned a refusal message, one responded saying that he was not nor had he ever been a commercial fisherman, and two failed to return the signed medical request consent form.

Fourteen individuals or 56% of the study subjects failed to respond in any manner to the mailed questionnaire format presented in section III-F.

The current status of protocol III participants is summarized in Table 27 Of the eleven individuals or 44% who responded to the mailed questionnaire format seven or 28% are complete or partially complete for validation procedures Two or 8% or complete without consent forms, and efforts are continuing to 1) obtain the consent forms of subjects 3 and 17 or 2) obtain a response indicating a refusal to cooperate with this aspect of the study procedure.

The response time for the return of the study materials for protocol III ranged between twelve to fifteen days for both mailings. These results indicate that the one month waiting period was an appropriate length of time for participant response. In addition, only one study packet was returned due to an incorrect mailing address and subsequent efforts to obtain the correct address were successful. No study materials were returned due to the death of a study participant. This suggests that information regarding commercial fishermen obtained from state files, publication lists, and fishing organizations was

TABLE 27

Status of Protocol III Participants

subject study number	subject status
1	No response following two mailings
2	responded on the second mailing indicating that he was never a commercial fisherman
3	responded on the second mailing - signed consent form has not been returned
4	responded on the second mailing - validation procedures are partially complete
5	No response following two mailings
6	No response following two mailings
7	responded on the first mailing - validation procedures are complete
8	responded on the second mailing - refusal
9	responded on the first mailing - validation procedures are complete
10	No response following two mailings
11	No response following two mailings
12	No response following two mailings
13	responded on the first mailing - validation procedures are complete
14	No response following two mailings
15	No response following two mailings
16	No response following two mailings
17	responded on the first mailing - signed consent form has not been returned
18	responded on the first mailing - validation procedures are partially complete
19	responded on the second mailing - validation procedures are partially complete
20	No response following two mailings
21	No response following two mailings
22	No response following two mailings
23	No response following two mailings
24	responded on the first mailing - validation procedures are complete
25	No response following two mailings

accurate with respect to address and reflected a living cohort.

A major problem experienced with the mailed questionnaire format was the incorrect or incomplete responses obtained from five of the nine study subjects who signed and returned the questionnaire. It is difficult to assess whether this was attributable to questionnaire length, questionnaire misinterpretation, or individual inconsistency. However, four individuals completed the questionnaire in its proper context suggesting that the difficulties with incomplete responses are most likely due to the length of the questionnaire and/or inconsistency on the part of the study subject.

In general, the participants correctly completed the questions regarding fishing practices and consumption patterns and their behavioral patterns (i.e., smoking, drinking). Incomplete or incorrect responses were most often encountered with the questions regarding familial medical histories.

Future application of this protocol procedure to a larger cohort should consider several modifications including:

1) a reduction of the waiting period for a participant response from one month to two to three weeks.
2) structural changes of the questionnaire to facilitate participant response.
3) telephone contact with study subject to encourage cooperation with the survey in the event that two mailings failed to elicit a response.

D. Discussion

A significant factor regarding the appropriateness of a commercial fishermen cohort to assess the potential health impacts of organic contaminants in the environment is the distribution of fish consumption, and thus potential exposure to organic contaminants, among this population.

A preliminary analysis was performed based upon the combined responses of protocols I and II to evaluate the number of fish meals per months, the number of years consuming fish with this frequency, the number of pounds of fish consumed per year, and the types of fish most often consumed. Table 28 summarizes these preliminary results.

In general, the combined responses of individuals from protocols I and II suggest that commercial fishermen eat fairly large quantities of fish and, for the most part, have been doing so for a good many years. Approximately 14% of the respondents consume between 0-3 fish meals per month, 42% consume between 4-7 fish meals per month and 44% consume ≥ 8 fish meals per month. The fish species most frequently mentioned as being consumed were perch, followed by lake whitefish, lake herring, and lake trout.

It is interesting to note the distribution of study subjects from protocols I and II regarding the pounds of fish consumed per year; the majority of which report ≤ 50 lbs/year. These results appear to be inconsistent with the results regarding the number of fish meals consumed per month. A possible explanation is that some individuals consume large quantities (i.e., ≥ 2 lbs) of fish at one sitting compared to other individuals who consume small quantities (i.e., ≤ ½lb). To resolve this potential inconsistency an additional question regarding the average amount of fish consumed per meal should be considered for inclusion in a large-scale study.

These preliminary results suggest that there is a good distribution

TABLE 28

PRELIMINARY RESULTS FOR PROTOCOLS I AND II

Distribution of study subjects from Protocols I and II regarding the number of fish meals consumed per month		Distribution of study subjects from Protocols I and II regarding the number of years fish were consumed with this frequency		Distribution of study subjects from Protocols I and II regarding the number of pounds of fish consumed per year		Types of fish most often mentioned as consumed by respondents from Protocols I and II	
number of fish meals per month	number of study subjects	number of years fish consumed with this frequency	number of study subjects	number of pounds of fish consumed per year	number of study subjects	fish species	* number of study subjects
0-1	3	0-5	3	0-25	10	Perch	21
2-3	2	6-10	2	26-50	9	Lake whitefish	14
4-5	12	11-15	1	51-75	6	Lake herring	12
6-7	3	16-20	3	76-100	3	Lake trout	11
8-9	5	21-30	7	101	9	Roughfish	6
10	12	31	21			Smelt	5
						Salmon, Walleye	4
						Chubs	3
						Northern Pike, Burbot, Pickerel	2
						Bass, Panfish, other trout, Menominee	1

*Note: these numbers do not add to 37 since individuals mentioned more than one species of fish consumers among this cohort ranging from 0-1 meals per month to more than 10 meals per month. In addition, there is a good distribution of fish consumers based on yearly consumption amounts ranging from less than 25 lbs/year to greater than 100 lbs/year.

Humphrey and his associates measured the PCB levels in persons consuming sport fish and reported that the most frequently recorded quantity of fish actually consumed was in the 25-35 pounds per year range. However, the number of participants reporting a consumption greater than 35 pounds per year was low (52). Approximately 25% of Humphrey's cohort consumed ≥ 30 pounds of fish per year. A comparison with preliminary pilot results indicates that approximately 50% of the commercial fishermen cohort consume ≥ 50 pounds of fish per year. These findings suggest that a population sub-group consuming considerably greater quantities of fish can be identified and are willing to participate in an epidemiologic investigation.

I. Cost Analysis for Protocol Implementation

A. Protocol I

The cost per protocol I participant can be approximated by determining the cost of individual study instruments and procedures. The following is a list with approximate costs of study materials and procedures used in protocol I.

letter or introduction	$ .05
medical consent form	.05
return-addressed, stamped envelope	.23
mailing envelope and postage	.23
long distance phone call(interview) $.38 x 35 minutes	13.50
second request for consent form	.05
medical consent form	.05
return-addressed,stamped envelope	.23
mailing envelope and postage	.23
Total	$14.62

Based upon the price of a long distance phone call to New York for an average interview time of thirty-five minutes the estimated phone costs are $13.50 per study subject. In addition, the costs of mailing both an introductory study packet as well as a second request for medical consent forms are included. (On the average there was one additional request for the medical consent form per study subject). The total cost for interviewing and obtaining returned study materials from protocol I participants is approximately $15.00 per subject.

Not included in this approximation are secretarial and interviewer costs. Considering these additional expenses the cost per protocol I participant is approximately $20.00. However, it must be kept in mind that these are estimated costs based on average participant's response times. In general, telephone costs (the major expense of this protocol) will vary according to subject residence and length of interview time.

B. Protocol II

The cost per protocol II participant can be approximated by determining the cost of individual study instruments and procedures. The following is a list with approximate costs of study materials and procedures used in protocol II.

letter of introduction	$ .05
medical consent form	.05
a set of questions (5 pages)	.25
return-addressed, stamped envelope	.23
mailing envelope and postage	.72
long distance phone call $.38 x 35 minutes	13.50
second request for consent form	.05
medical consent form	.05
return-addressed, stamped envelope	.23
mailing envelope and postage	.23
Total	$15.36

The expense figures for protocol II are similar to those of protocol I. However, the mailing costs, the cost for an enclosed set of questions, and a slight increase in secretarial costs increase the overall cost per protocol II participant. Considering these additional expenses the cost per protocol II participant is approximately $22.00. The variables associated with this cost approximation are similar to those discussed for protocol I.

C. Protocol III

The cost per protocol III participant can be approximated by determining the cost of individual study instruments and procedures. The following is a list with approximate costs of study materials used in protocol III.

letter of introduction	$ .05
medical consent form	.05
questionnaire (23 pages)	1.15
return-addressed, stamped envelope	1.45
mailing envelope and postage	1.62
second request for consent form	.05
medical consent form	.05
return-addressed, stamped envelope	.23
mailing envelope and postage	.23
Total	$ 4.88

The cost of a second mailing to 76% of the protocol III subjects averages out to be approximately $3.28 per participant. In addition, there was an average of one additional request for the medical consent form per study subject.

The cost for the mailed questionnaire format is approximately $8.00 per study subject. Considering additional secretarial expenses, involving increases in time and typing, the total costs are approximately $10.00 per study subject.

In summary, the costs associated with protocols I and II are very similar (approximately $20.00 per study subject) with protocol II being slightly more expensive. The cost associated with protocol III is cheaper by about half. However, it appears that both protocols I and II are more cost-effective in that they achieve a much higher rate of response than protocol III. In addition, the information obtained by protocols I and II is much more complete than that obtained in protocol III. These results suggest that the use of either protocol I or II would be more cost-effective in a large-scale study and less likely to be biased by non-response and incomplete information.

The cost-effectiveness of the added expense of protocol II will be determined following validation. If a significant percentage of responses obtained from protocol II participants are more accurate than those obtained from protocol I, then the added expense of protocol II procedures may be warranted in a larger study. Evaluation of the accuracy of responses from protocols I and II, as determined through preliminary validation, indicate that these differences are slight. Therefore, protocol I appears to be the most efficient and cost-effective.

The costs associated with validation and tracing procedures are the same regardless of the protocol and are discussed in the following section.

D. Validation

The cost per study participant for validating medical histories is based upon the following list of study instruments.

a letter requesting medical records	$.05
a copy of the signed consent form	.05
a medical records abstracting form (4 pages)	.20
a return-addressed, stamped envelope	.40
a mailing envelope and postage	.23

On the average, two requests were sent to each medical source. In addition, the cost associated with obtaining the addresses of medical sources involved an average of three long-distance calls per source given by the study subject. These include:

1 call to directory assistance for the phone number

1 call to a related medical source for information $2.07

1 call to actual medical source for an address $1.31

There was an average of three medical sources contacted per study subject. As a result the cost associated with the validation of the medical histories is approximately $16.00 per study subject.

Not included in this approximation are secretarial and tracer costs. Considering these additional expenses, (using an average of one hour to obtain the mailing address of the medical sources mentioned by the study subjects), the total cost is approximately $21.00 per study subject.

E. Tracing

The cost associated with tracing individuals was minimum in this pilot study since most of the addresses were current. In several instances, phone calls were made to verify the addresses of those individuals with unlisted phone numbers, no phones, or who were not at home at the time of the call. This cost amounted to an average of approximately $1.00 per study subject.

The cost associated with tracing medical sources (i.e., deceased physicians) is included in the validation expenses per study subject.

Conclusions

A pilot study was initiated to determine the feasibility of an epidemiologic investigation, among commercial fishermen, of the association of PCBs on health. Commercial fishermen were selected as a potential "high risk" population because of their fish consumption habits and the availability of licensing records from which a cohort could be extracted. The purpose of this pilot study was to evaluate three research protocols to determine their effectiveness as epidemiologic tools and the appropriateness of commercial fishermen as a cohort.

The pilot study has provided the following conclusions:

1. The addresses of all study subjects in Protocols I and II were verified. The format of Protocol III was structured such that the verification of subject location was not applicable.
2. The response **rates** for Protocols I and II were similar (72% and 76% of the total cohort respectively).
3. The response **rate** for Protocol III was 44% after two mailings.
4. Protocols I and II were more effective in producing:
   a) answers in the correct format,
   b) the highest response rates, and
   c) the most accurate information.
5. The differences between Protocols I and II regarding accuracy of information are slight. Therefore, Protocol I appears to be the most efficient and cost-effective of the three protocols tested.
6. The fish consumption patterns among this cohort, obtained by compiling the information from Protocols I and II, indicates several trends. These include:
   a) a good distribution of fish consumption per month among the cohort,
   b) a good distribution of the number of years fish have been consumed with this frequency among the cohort,

c) a good distribution of the quantity of fish consumed per year among the cohort, and

d) the preferred consumption of several target fish species from the Great Lakes among this cohort.

These results suggest that commercial fishermen were appropriate as a study cohort and that Protocol I would be the most effective and cost-efficient method of epidemiological ascertainment.

In addition to the pilot study an analysis of the morbidity and mortality patterns of the Great Lakes populations was conducted. State vital statistics regarding county fetal, neonatal, and infant death rates and congenital anomaly rates were examined for the states of Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio for every fifth year from 1950 to 1975 and the year 1977. Furthermore, an evaluation of the county site, race, sex, and age-adjusted cancer mortality rates from the National Cancer Institute's publication "U.S. Cancer Mortality: 1950 - 1969" was conducted (80).

These analyses have generated the following conclusions:

1. There were no significant trends regarding the percent differences for neonatal death rates and fetal death rates among "lake bordering " and "non-lake bordering" counties having rates $\geq$ 1 standard deviation higher than their respective state means.
2. There was a slight trend regarding the difference between percent of live births with congenital anomalies among "lake bordering" and "non-lake bordering" counties having rates $\geq$ 1 standard deviation higher than their respective state means. This trend favored the "non-lake bordering" counties.
3. The fertility rates for the eight states were not analyzed due to inconsistent reporting between states.

4. An evaluation of the cancer rates of the counties of the Great Lakes states, stratified according to proximity to the lake, indicated an increasing trend with proximity to the Lakes for esophageal and stomach cancers. These trends are still apparent after counties with population centers ≥ 100,000 have been excluded from the analysis.

These results suggest that "lake-bordering" populations (i.e., white populations) experience higher rates of mortality due to stomach and esophageal cancers as compared to "non-lake bordering" counties. This trend is consistent when the potential confounding factor of large urban centers is removed.

There were no apparent trends regarding the fetal death rate, the neonatal death rate, and the percent of live births with congenital anomalies, among "lake-bordering" and "non-lake bordering" counties.

Methodological Approaches for Continued Research

The purpose of this study has been to determine whether it is feasible to ascertain analytically any adverse human health effects from organic contaminants released into the Great Lakes basin. The results of the feasibility study indicate that current epidemiologic methodologies are available for detection of human pathologic responses to organic chemicals. This conclusion is based upon the following findings:

1. Federal and State agencies responsible for monitoring environmental indices have reported detectable levels of organic contaminants in the ambient air, waters, soils, lake sediments, and fish species of the Great Lakes basin.
2. Animal research studies have demonstrated that organic chemicals are fat soluble and bioaccumulate in aquatic food chains. Animal dietary studies have shown that ingestion of contaminated foodstuffs may produce a variety of pathologic states.
3. Human epidemiologic studies of acute toxic exposures to organic chemicals have reinforced the findings of animal dietary studies.
4. Existing data sets (e.g., the Public Health Service publication (80) titled: U.S. Cancer Mortality by County: 1950-1969) may be utilized to define patterns of morbidity and mortality experienced by human populations of the Great Lakes basin.
5. The Great Lakes Study Pilot Project on Commercial Fishermen has data indicating that this occupational cohort consumes target fish species which have been implicated as providing an exposure potential to consumers. Furthermore, some fishermen have reported the consumption of large quantities of target species and may constitute a "high-risk" population for

disease.

Therefore, full scale studies are warranted in addressing the issues of whether the organic contaminants released into the Great Lakes basin are causing a demonstrable adverse human health effect. To discern the possible complex "agent-host-environment" interactions involved in this process, multiple approaches will be necessary utilizing the analytical techniques from many disciplines. The methodologies utilized in the feasibility study have been incorporated in the following multifaceted protocol:

Analysis of the 1950-1969 County Cancer Mortality Rates:

The purpose of refining the evaluation of the county 1950-1969 cancer mortality data set (80) is to identify the variables responsible for the discrepancies noted in analysis five. The procedures to be added to analysis five are as follows:

1. The standard errors for each mean age-adjusted site-race-sex specific cancer mortality rate would be calculated for the three Orders.
2. Confidence intervals would be examined comparing the rates of Order 1 against Orders 2 and 3.
3. For those Order 1 sites whose mean age-adjusted site-race-sex specific cancer mortality rate confidence intervals lie outside the corresponding confidence intervals for the other Orders, data will be gathered on those factors which may be considered as confounding variables. Demographic information acquired may include mean income for each county and the percentage representation by race, religion, industry, and agriculture. Additional data will include the types of occupations located

within a county which may provide exposure to other agents suspected to cause the disease under consideration. Statistical techniques (e.g., regression analysis) will be implemented to discern the influence each possible confounding variable may have on the observed differences between rates.

4. Environmental monitoring has indicated that the Great Lakes vary in the degree to which they are contaminated by organic chemicals. A second analysis would be conducted which stratified the counties by lake. The purpose of this second evaluation would be to determine if the trends noted for the Order 1 counties were due to a subset of Order 1 counties associated with a particular lake.
5. In analysis five all counties which were not of the first or second Order were considered third Order counties. In the reanalysis only those counties which are geographically adjacent to the second Order counties, and not of the first Order, would be considered third Order counties.

The incorporation of these revisions into the protocol for analysis five would provide two benefits. First, it would aid in defining those factors which have produced the differences noted in cancer mortality among the counties. Secondly, the utility of a data bank such as the county 1950-1969 cancer mortality data (80) will be evaluated for its usefulness in generating testable hypotheses regarding disease etiology.

A Comparative Morbidity/Mortality Survey of Great Lakes Counties with Varied Levels of Organic Contamination:

Two Great Lakes counties would be selected for comprehensive reviews of environmental and human health parameters. One county known from state and federal monitoring programs to be extensively contaminated by organic compounds would be selected for comparison to a county known to have minimal contamination. The counties would be comparable on the demographic variables listed below.

Upon selection of the study counties, thorough environmental characterizations would be initiated. The following information would be evaluated:

1. The data files of the regional Environmental Protection Agency (EPA) offices would be reviewed regarding surface water dischargers. The drinking water sources would be assessed in terms of location and mineral analysis.
2. Environmental evaluations would be conducted on ambient waters, sediments, ambient air, and landfills.
3. A market basket analysis would be requested from the Department of Public Health on foodstuffs consumed in the communities.
4. Industries and agricultures would be reviewed in terms of the types of health risks posed to the community and their employees.

The human health parameters to be reviewed by county include:

1. age and cause-specific death rates
2. infant, neonatal, and fetal death rates
3. percent of live births with congenital anomalies
4. birth rates and fertility ratios
5. percent of hospital admissions and out-patient services by diagnostic category
6. medical care utilization rates

Demographic data would be obtained for both counties regarding:

1. population distribution by age, race, and sex

2. average income and education

3. percent of the population employed in various occupations

4. the percent of inhabitants living in urban and rural areas

5. population densities

The data on human health parameters will be examined for disparities between the two counties. If the difference in rates cannot be explained by known risk factors or confounding variables, the routes of exposure for possible etiologic agents will be discerned.

This investigation would require a field staff for record abstracting and patient interviews. Technicians would be required for additional environmental sampling and laboratory analysis. The justification for this study is two-fold. First, the routes of agent-host-environment interaction need to be identified. Second, it could allow a statement as to whether existing levels of organic contaminants are associated with adverse health effects in the populations studied.

Health Survey of Great Lakes Fishermen

The pilot study of Great Lakes commercial fishermen has provided evidence that some fishermen eat large quantities of fish species known to have levels of organic contaminants which may exceed Food and Drug Administration (FDA) limits. The pilot project has developed and pretested material which can be utilized in large scale studies.

The fishermen's health study would be implemented in two phases. The first phase would focus on interviewing all currently licensed commercial fishermen in the Great Lakes (U.S. license holders only). The names and addresses of the registered commercial fishermen would be obtained from licensing offices of state governments. The second component of the study would be undertaken with the cooperation of the

Wisconsin Department of Natural Resources (DNR). Preliminary discussions have been held with the DNR for a joint survey of Wisconsin sport fishermen. In 1982 a stratified* one-percent random sample of licensed sport fishermen would be drawn from DNR files. Each individual would be mailed a postcard which has a series of questions on fishing practices and fish consumption patterns. Upon return of the completed postcard, a second stratified random sample will be initiated based upon levels of fish consumption. Those sport fishermen selected in the second sample and all licensed commercial fishermen will comprise the cohort for the "Health Study of Great Lakes Fishermen."

Survey interviewers would obtain the fishermen's phone numbers from "directory assistance" and call to establish a telephone interview. The methods for tracing, subject contact, interviewing, validation, and data analysis have been outlined in protocol I of the Great Lakes commercial Fishermen Pilot Project.

A subset of the study cohort will be chosen for a survey on dietary habits and practices. Project staff will conduct in-person dietary interviews with the families of fishermen. Fish samples will be taken for laboratory analysis. A seven day dietary record form will be given to family members to complete and return to the study office. This phase of the study is necessary to document potential exposure to organic contaminants and as a validity check on the questionnaire. It is understood that the present documentation of the ingestion of contaminated fish does not assume that fish eaten at other times were contaminated. Current clinical effects such as a cancer would require exposure to the etiologic agent prior to the sampling.

*Stratification would be based on the type of sport fishing license purchased in 1982.

The data acquired from the "Health Study of Great Lakes Fishermen" will address the following issues:

1. Is the fish consumed by Great Lakes fishermen contaminated by organic chemicals? If so, do the levels of contamination lie within F.D.A. limits?
2. Are the methods of fish preparation (i.e., broiling or smoking) contributing to the level of contaminants in the fish consumed?
3. Is the information reported in the pilot study questionnaire consistent with other dietary instruments?
4. Are individuals who consume large quantities of fish at a greater risk of disease than low or non-consumers? If so, what clinical effects are manifested in fish consumers?
5. If high fish consumption is a risk factor for disease, are the agent-host-environment interactions defined? Are these interactions biologically plausible? If yes, which link in the chain of transmission could be removed for preventive measures?

Each of the three proposed studies addresses an important aspect of the issue under consideration. The first study examines the utility of existing data sources for the identification of mortality and morbidity patterns. The second study will focus on the health characteristics and trends of communities with varied levels of contamination. The last study will discern the health status of a possibly "high-risk" group.

There is a paucity of information in the scientific community on the human health effects of chronic low level exposures to environmental pollutants. The three-faceted approach outlined above can help to increase our understanding of this vital issue.

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Addendum

Survey of Large Cohort of Commercial Fishermen

A. Introduction

With the demonstration of the apparently more cost-effective telephone interview approach (Protocol I) in the pilot feasibility study, it was decided to proceed with a study of a large commercial fishermen cohort using an improved questionnaire (Appendix II) based on experiences with the pilot questionnaires. This was possible with the time remaining in the basic contract.

There follows a detailed description of this survey and its preliminary results. It should be noted that the completion of this initiated study, in accordance with the analytic proposals in Appendices IV and V, is contingent upon renewal funding. In addition, the proposed coding instructions in Appendix IV apply to the questionnaire used in the survey of the large cohort of commercial fishermen, whereas the analytic proposals in Appendix V apply to the questionnaires used in the small-scale pilot study.

To evaluate the potential size of a cohort of commercial fishermen it was decided to compile a list based upon all available records in the Great Lakes states. This procedure would hopefully provide additional information regarding cohort size.

B. General Description of the Cohort

During January and February of 1982 the study supervisor traveled to the states of Indiana, Ohio, Pennsylvania, and Wisconsin to obtain listings of potential commercial fishermen. Listings from Illinois, Michigan, Minnesota and New York could be mailed to the Division and thus visits were not required.

DNR and license bureau records varied in their completeness, but all eight states were able to provide listings back to 1975. In many states, roster entries included company names such as Steve Phalen Fisheries and H and G Fish Company. These entries pose a problem as any number of fishermen and crew members can be employed under this blanket company license and will not appear as individual license holders.

Table 29 describes the availability of records and approximate number of commercial fishermen by state.

Table 29. Historical Perspective of Commercial Fishing Records

State	Availability of Records	Approximate Number of Commercial Fishermen
Ohio	back to 1968	200
Illinois*	back to 1975	5
Indiana	back to 1974	80
Minnesota	back to 1943	250
Michigan	back to 1971	300
Wisconsin	back to 1971	300
Pennsylvania	back to 1961	200
New York	back to 1971 Dunkirk Station	150
	back to 1971 Cape Vincent Station	86
	Total	1,571 + 75* (Illinois) 1,646

*Have requested remaining records back to 1970; DNR official stated that he would guess approx. 75 commercial fishermen held licenses from 1970-1975.

The results of this investigation indicate that there are approximately 1,600 independent commercial fishermen from the eight Great Lakes States dating back as far as 1968. However, for initiation of this survey the lists detailed on page 91 of Report II were used to generate study participants. It can be assumed, therefore, that the use of the lists dating back to 1968 would provide another 600 individuals.

For purposes of this survey it was decided to restrict study eligibility to individuals possessing a commercial fishing license from any of the eight Great Lakes States and fishing Great Lakes waters. As a result of eligibility requirements, individuals employed under a company license, inland waters commercial fishermen and crew members of license holders were not included in the survey. The use of these individuals in an expanded study would substantially increase cohort size.

C. Survey Implementation

Five Senior Survey Interviewers were hired and began interviewing November 13, 1981 after a three day training session conducted by the project supervisor. General principles of interviewing, field procedures, and question-by-question specifications were reviewed during the first training session, followed by role plays, mock interviews and the distribution of assignments during the second session.

Interviewers were given 10-20 assignments each week and the study supervisor met with each interviewer once a week to distribute new assignments and review the previous week's completed interviews. Detailed information regarding study materials and procedures can be found in Appendix III.

Each completed questionnaire was edited by the study supervisor for errors, omissions and contradictory and/or confusing data. When this occurred, the supervisor or interviewer re-contacted the respondent to obtain the correct information. Not only did this editing process produce as thorough and complete an interview as possible, it also provided the study supervisor with an accurate ongoing evaluation of the interviewer's work.

Tracing was not a major problem in the Great Lakes Fishermen Health Study as the lists of potential commercial fishermen were obtained in 1980. Respondents who had moved from the last known address were usually located with few major problems since the commercial fishermen tended to be an informed, close-knit community. In addition to identifying respondents who had moved, fellow fishermen were invaluable in supplying information about vacationing respondents and confirming or negating the commercial fishing status of unavailable respondents.

Due to time constraints no attempts were made to validate the respondents' medical history although consent forms were requested from each participant. The focus of this survey was to collect complete information on as many fishermen and their families as possible via the Great Lakes Fishermen Health Survey (see Appendix II).

D. Preliminary Survey Results

From an original roster of 1,025 licenses 71 were eliminated because they were owned by companies. Of the remaining 954 individuals with licenses, 241 were ineligible because they did not fish commercially. The reasons why individuals possessed a commercial licences but did not fish include:

1. The individual had taken out a license, but never used it due to the prohibitive cost of equipment and DNR regulations.
2. The individual held the license in name only while another family member(s) did the actual fishing.
3. Depending on the state or particular area, owners of charter boat services, hatcheries, and bait and tackle shops were either required to purchase a license or held a license "just in case".
4. The individual fished on inland rivers and lakes only.

Thirty one individuals were deceased and another 41 were unavailable during the time of interviewing due to winter vacations and/or requested disconnected telephones. Repeated attempts to contact the unavailable individuals were made throughout the duration of the interviewing phase.

Fifty one individuals initially refused to participate in the study. Of these 51, 10 were converted into complete interviews achieving a refusal conversion rate of 19.6%, leaving a total of 41 refusals. Six individuals could not be located through tracing efforts.

In summary, there was an original roster of 1,025 licenses which provided 675 eligible study participants. Of the 675, interviews were obtained on 587 individuals for a response rate of 87%. Out of 587 respondents, 483 fishermen had wives (wives who were also fisherwomen are included in this category), 75 had no wives (i.e., wives were deceased, divorced over 10 years or single, never married) and 29 (6%) of the respondents wives refused to participate in the study. The response rate among wives of study participants was 94%.

Table 30 presents the general results of the survey and Table 31 presents the distribution of eligibles, respondents and response rates by state.

Table 30. Breakdown of Study Eligibles, Respondents and Survey Response Rates

Original Sample	1,025	
Company license	71	
Ineligible	241	
Deceased	31	
Other*	7	
	675	Study Eligibles
Refusals	41	
Unavailables	41	
Lost to follow-up**	6	
	587	Study Respondents Response Rate = 87%
Fishermen w/o wives	75	
Refusals (wives)	29	
	483	Study Respondents (wives) Response Rate = 94%

*Other represents duplicate names

**Lost individuals could not be located through tracing efforts

Table 31. Distribution of Study Eligibles, Respondents and Response Rates by State*

	IL	IN	MI	MN	NY	OH	PA	WI
Original Sample	5	63	147	101	49	110	41	438
Ineligibles	0	19	39	16	18	45	18	86
Deceased	0	1	1	6	0	0	0	23
Other	0	0	3	0	0	2	0	2
POSSIBLE INTERVIEWS	5	43	104	79	31	63	23	327
Refusals	1	3	5	6	1	4	1	20
Unavailables	2	3	11	2	4	6	1	12
Lost	0	1	1	1	0	1	0	2
COMPLETED INTERVIEWS	2	36	87	70	26	52	21	293
Response Rate	40%	84%	84%	89%	84%	83%	91%	90%
% Contribution to total cohort	0.3%	6.1%	14.8%	11.9%	4.4%	8.9%	3.6%	49.9%

*Fishermen only, wives not included in this distribution

The responses of survey participants regarding fish consumption practices, number of years fish have been consumed with this frequency and preferred fish species is presented in Table 32. In general, the responses confirm the results of the pilot study in that commercial fishermen and their families consume large quantities of fish and have been doing so for many years. In addition, the preferred fish species are those which have demonstrated elevated levels of PCB contamination (see Report I).

These findings support those from the pilot study and suggest that a population of commercial fishermen may provide valuable information regarding potential health risks associated with ingestion of organic contaminants via fish.

It is recommended that the study be expanded to include individuals employed by commercial fishing companies and crew members of commercial fishermen as eligible study participants. Finally, the data collected should be thoroughly analyzed in accordance with proposals in Appendices IV and V to evaluate potential associations between fish consumption and health among fishermen and their families.

Table 32. Preliminary Results for Great Lakes Study

Distribution of study respondents regarding the number of fish meals consumed

Number of fish meals consumed	Number of Study Respondents	%
Never	9	1.5
1-2 times/week	340	57.9
3-5 times/week	76	12.9
6-7 times/week	12	2.0
<1 time/month	29	4.9
1 time/month	40	6.8
2-3 times/month	81	13.8

Distribution of study respondents regarding the number of years fish were consumed with this frequency

Number of years fish consumed with this frequency	Number of study respondents	%
0 - 5	44	7.5
6 - 10	76	12.9
11 - 15	39	6.6
16 - 20	39	6.6
21 - 30	90	15.3
31+	299	50.9
31+		

Types of fish most often mentioned as consumed by study respondents

Fish species	*Number of study respondents
Perch	344
Lake Whitefish	204
Lake Trout	143
Lake Herring	71
Smelt	59
Chub	57
Walleye	45
Catfish	33
Salmon	24
Burbot	22

*Numbers do not total 587 because individuals mentioned more than one species.

APPENDIX I

Rates and Ratios for Thirty-five Cancer Sites for "Urban and Rural" and "Rural" Analyses in the Great Lakes Basin

CANCER SITE: Lip

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.3491	0.0110	0.0124	0.0064
Averaged 2nd order rate:	0.3910	0.0141	0.0000	0.0050
Averaged 3rd order rate:	0.3744	0.0287	0.2742	0.0012
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.8928	0.7801	------	1.2800
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.9324	0.3833	0.0452	5.3333
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0443	0.4878	------	4.1667
Sum of weighted rates:	0.3696	0.0227	0.1573	0.0034
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9445	0.4846	0.0788	1.8823
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0579	0.6211	------	1.4706
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0130	1.2643	1.7437	0.3529
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

CANCER SITE: Salivary Glands

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.4229	0.2318	0.0967	0.0830
Averaged 2nd order rate:	0.3397	0.1971	0.0186	0.6525
Averaged 3rd order rate:	0.3991	0.2210	0.2127	0.3129
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.2449	1.1755	5.1989	0.1272
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0596	1.0484	0.4546	0.2653
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.8512	0.8918	0.0874	2.0860
Sum of weighted rates:	0.3991	0.2214	0.1574	0.2380
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0596	1.0470	0.6143	0.3487
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.8512	0.8902	0.1182	2.6155
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0000	0.9982	1.3513	1.3147

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

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CANCER SITE: Nasopharynx

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.2744	0.1072	0.2337	0.0387
Averaged 2nd order rate:	0.3223	0.0952	0.0639	0.0050
Averaged 3rd order rate:	0.2758	0.0829	0.0814	0.0280
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.8514	1.1260	3.6573	7.7400
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.9953	1.2931	2.8710	1.3821
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.1690	1.1484	0.7850	0.1786
Sum of weighted rates:	0.2802	0.0904	0.1408	0.0312
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9793	1.1858	1.6598	1.2404
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.1502	1.0531	0.4538	0.1603
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9843	0.9170	0.5871	0.8974
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.		X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Tongue and Mouth

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	3.8479	0.9223	1.1997	0.4874
Averaged 2nd order rate:	3.3003	0.8795	1.8376	0.5698
Averaged 3rd order rate:	3.0066	0.7318	4.4046	1.6990
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.1660	1.0487	0.6529	0.8554
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.2798	1.2603	0.2724	0.2869
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0976	1.2018	0.4172	0.3354
Sum of weighted rates:	3.2539	0.7954	3.0113	1.1753
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.1825	1.1595	0.3984	0.4147
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0143	1.1057	0.6102	0.4848
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9240	0.9200	1.4627	1.4456

Trends

	White Males	White Females	Non-white Males	Non-white Females
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Esophagus

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.2989	0.9902	8.2348	1.0127
Averaged 2nd order rate:	3.2781	0.7857	5.0238	25.7817
Averaged 3rd order rate:	2.9805	0.7503	5.8199	0.6422
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.3114	1.2603	1.6392	0.3928
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.4423	1.3199	1.4149	1.5769
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0998	1.0473	0.8632	40.1459
Sum of weighted rates:	3.3514	0.8152	6.7378	1.8978
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.2827	1.2147	1.2222	0.5336
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9781	0.9638	0.7456	13.5850
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.8893	0.9204	0.8626	0.3384
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Stomach

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban
centers with 100,000 inhabitants are
excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	19.3606	9.2993	23.9864	8.8318
Averaged 2nd order rate:	16.6168	7.6511	19.9937	14.5268
Averaged 3rd order rate:	7.1509	4.8292	7.4590	14.5268
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.1651	1.2154	1.1997	0.6080
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.3525	1.2395	1.7868	1.3334
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.1609	1.0198	1.4894	2.1933
Sum of weighted rates:	15.8535	7.9769	17.8695	7.8361
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.2212	1.1658	1.3423	1.1271
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0481	0.9592	1.1189	1.8538
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.5772	0.6054	0.4174	0.4773
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X	X	
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Large Intestine

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	16.5203	16.5682	9.7122	15.9118
Averaged 2nd order rate:	16.0048	16.5117	11.2259	9.1557
Averaged 3rd order rate:	15.8063	16.9205	11.0775	15.3798
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0322	1.0034	0.8652	1.7379
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0452	0.9792	0.8767	1.0346
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0125	0.9758	1.0134	0.5953
Sum of weighted rates:	16.0110	16.7893	10.5440	15.3129
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0318	0.9868	0.9211	1.0391
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9996	0.9835	1.0647	0.5979
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9872	1.0078	1.0506	1.0044

Trends

	White Males	White Females	Non-white Males	Non-white Females
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

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CANCER SITE: Rectum

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	7.7925	4.8053	2.2489	3.1272
Averaged 2nd order rate:	7.8417	5.0198	9.1949	1.1791
Averaged 3rd order rate:	7.2972	4.7094	5.0750	3.1700
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9937	0.9573	0.2446	1.8191
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0679	1.0204	0.4431	0.9865
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0746	1.0659	1.8117	0.5423
Sum of weighted rates:	7.4809	4.7652	4.1549	3.0892
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0416	1.0084	0.5413	1.0123
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0482	1.0534	2.2130	0.3817
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9754	0.9883	1.2214	1.0262

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Liver

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	5.1953	6.5479	6.6440	5.9107
Averaged 2nd order rate:	4.6395	6.0074	5.8985	5.0079
Averaged 3rd order rate:	4.8028	6.2763	5.6348	4.8715
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.1198	1.0900	1.1264	1.1803
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0817	1.0433	1.1791	1.2133
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.9660	0.9672	1.0468	1.0280
Sum of weighted rates:	4.8874	6.3187	6.0473	5.2839
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0630	1.0363	1.0987	1.1186
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9493	0.9335	0.9754	0.9478
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9827	0.9933	0.9318	0.9220

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Pancreas

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	9.2717	6.0605	3.8775	10.7675
Averaged 2nd order rate:	8.9293	5.5112	5.7570	2.9088
Averaged 3rd order rate:	8.4645	5.4478	7.7707	3.9151
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0383	1.0997	0.6735	3.7017
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0954	1.1125	0.4990	2.7502
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0549	1.0116	0.7409	0.7430
Sum of weighted rates:	8.7206	6.8162	5.6109	8.8068
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0632	0.8891	0.6911	1.1613
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weightei rates}}$:	1.0239	0.8085	1.0260	0.3303
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9706	0.7992	1.3849	0.4445
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Nose and Middle Ear

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.3829	0.2280	0.3576	9.4382
Averaged 2nd order rate:	0.5282	0.1785	0.4094	0.2148
Averaged 3rd order rate:	0.4440	0.2280	0.2673	0.1796
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.7249	1.2273	0.8735	2.0400
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.8624	1.0000	1.3378	2.4399
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.1896	0.7829	1.5316	1.1960
Sum of weighted rates:	0.4369	0.2051	0.3100	0.2823
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8764	0.1116	1.1535	1.5522
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.2090	0.8703	1.3206	0.7609
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0162	1.1116	0.8622	0.6362

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Larynx

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	2.3800	0.1546	1.8640	0.2067
Averaged 2nd order rate:	1.8688	0.2131	1.9599	0.1952
Averaged 3rd order rate:	1.7748	0.1774	1.6403	0.9280
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.2736	0.9516	0.9516	1.0589
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.3401	0.8715	1.1370	0.2227
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0530	1.2012	1.1948	0.2103
Sum of weighted rates:	1.9407	0.1752	1.7447	0.6136
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.2264	0.8824	1.0689	0.3369
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9629	1.2163	1.1233	0.3181
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9145	1.0126	0.9402	1.5124
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Trachea, Bronchus and Lung

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	32.9002	5.1322	29.6472	5.7151
Averaged 2nd order rate:	30.6619	5.1388	21.9218	3.2147
Averaged 3rd order rate:	28.5293	5.1546	27.7351	5.0540
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0730	0.9987	1.3524	1.7778
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.1532	0.9956	1.0689	1.1308
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0747	0.9969	0.7904	0.6361
Sum of weighted rates:	29.8764	5.1473	28.2114	5.2313
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.1012	0.9971	1.0509	1.0925
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0263	0.9983	0.7771	0.6145
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9549	1.0014	0.9831	0.9661
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

CANCER SITE: Breast

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.2661	25.5191	0.2154	23.0836
Averaged 2nd order rate:	0.1841	25.0840	1.7380	27.6612
Averaged 3rd order rate:	0.2429	24.1887	0.2499	17.5420
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.4554	1.0173	0.1239	0.8345
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0955	1.0550	0.8616	1.3159
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.7579	1.0400	6.9520	1.5769
Sum of weighted rates:	0.2428	24.6189	0.3082	20.1563
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0960	1.0366	0.6989	1.1452
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.7582	1.0189	5.6392	1.3723
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0004	0.9825	0.8108	0.8703
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.		X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Cervix Uteri

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:		8.1267		15.3534
Averaged 2nd order rate:		7.8110		23.0495
Averaged 3rd order rate:		7.9403		9.4707
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:		1.0404		0.6661
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:		1.0235		1.6211
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:		0.9837		2.4338
Sum of weighted rates:		7.9749		12.3712
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:		1.0190		1.2411
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:		0.9794		1.8631
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:		0.9957		0.7655

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Corpus Uteri

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:		6.5227		11.5115
Averaged 2nd order rate:		6.8524		10.6140
Averaged 3rd order rate:		6.8903		9.0597
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:		0.9519		1.0846
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:		0.9466		1.2706
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:		0.9945		1.1716
Sum of weighted rates:		6.7925		10.0872
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:		0.9603		1.1412
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:		1.0088		1.0522
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:		1.0144		0.8981
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

CANCER SITE: Ovary and Fallopian tube

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:		8.3035		4.4672
Averaged 2nd order rate:		8.6594		5.9559
Averaged 3rd order rate:		8.4251		6.3573
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:		0.9589		0.7501
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:		0.9856		0.7027
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:		1.0278		0.9368
Sum of weighted rates:		8.4175		5.6004
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:		0.9865		0.7977
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:		1.0287		1.0635
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:		1.0009		1.1351

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Prostate

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	18.2989		17.2375	
Averaged 2nd order rate:	18.5688		15.9260	
Averaged 3rd order rate:	18.3151		21.8424	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9855		1.0823	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.9991		0.7892	
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0138		0.7291	
Sum of weighted rates:	18.3369		19.7328	
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9979		0.8735	
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0126		0.8071	
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9988		1.1069	

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

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CANCER SITE: Testis

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.9401		0.0831	
Averaged 2nd order rate:	0.8991		0.0567	
Averaged 3rd order rate:	0.9189		0.1875	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0456		1.4656	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0231		0.4432	
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.9784		0.3024	
Sum of weighted rates:	0.9223		0.1399	
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0193		0.5940	
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9748		0.4053	
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9963		1.3402	

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Kidney

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.1238	2.1792	2.0134	0.5323
Averaged 2nd order rate:	3.6236	2.0213	2.3809	0.8328
Averaged 3rd order rate:	3.7703	2.0801	2.2870	1.7303
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.1380	1.0781	0.8456	0.6392
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0938	1.0477	0.8804	0.3076
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.9611	0.9718	1.0411	0.4813
Sum of weighted rates:	3.8465	2.0995	2.1832	1.2221
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0721	1.0380	0.9222	0.4356
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9420	0.9627	1.0905	0.6814
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9802	0.9908	1.0475	1.4158

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Bladder

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	6.8957	2.5049	4.8102	1.8569
Averaged 2nd order rate:	7.3321	2.2967	5.2621	2.0817
Averaged 3rd order rate:	5.8743	2.1449	2.6309	2.6733
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9405	1.0906	0.9141	0.8920
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.1739	1.1678	1.8283	0.6946
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.2482	1.0708	2.0001	0.7787
Sum of weighted rates:	6.2875	2.2523	3.6211	2.3279
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0967	1.1122	1.3284	0.7977
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.1661	1.0198	1.4532	0.8942
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9343	0.9524	0.7265	1.1484
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.		X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Skin Melanoma

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.9569	0.7774	0.0464	0.0103
Averaged 2nd order rate:	1.0196	0.9110	0.0823	0.3984
Averaged 3rd order rate:	1.2218	0.9804	0.0702	0.3027
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9385	0.8533	0.5638	0.0258
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.7832	0.7929	0.6610	0.0340
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.8345	0.9292	1.1724	1.3161
Sum of weighted rates:	1.1327	0.9215	0.0613	0.1926
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8448	0.8436	0.7569	0.0534
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9001	0.9886	1.3426	2.0685
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0787	1.0639	1.1452	1.5716
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X 178	X		

CANCER SITE: Other skin

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	1.2889	0.5505	2.8011	0.1210
Averaged 2nd order rate:	1.3164	0.6241	1.0289	0.1402
Averaged 3rd order rate:	1.4384	0.6423	0.4887	0.4418
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9791	0.8821	2.7224	0.8630
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.8961	0.8571	5.7317	0.2739
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.9152	0.9717	2.1054	0.3173
Sum of weighted rates:	1.3873	0.6170	1.4306	0.3030
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9291	0.8922	1.9580	0.3993
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9489	1.0115	0.7192	0.4627
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0368	1.0410	0.3416	1.4581
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X	X		

CANCER SITE: Eye

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.1919	0.1871	0.0089	0.1484
Averaged 2nd order rate:	0.2052	0.1490	0.0345	0.0000
Averaged 3rd order rate:	0.2380	0.1946	0.0100	0.1363
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9352	1.2557	0.2551	------
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.8063	0.9615	0.8800	1.0888
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.8622	0.7657	3.4500	------
Sum of weighted rates:	0.2227	0.1881	0.0107	0.1350
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8617	0.9947	0.8318	1.0993
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9214	0.7921	3.2243	------
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0687	1.0346	0.9346	1.0096

Trends

	White Males	White Females	Non-white Males	Non-white Females
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X			

CANCER SITE: Brain and Nervous System

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.1597	2.7555	2.0993	4.5234
Averaged 2nd order rate:	4.3553	2.6536	1.1240	0.5267
Averaged 3rd order rate:	3.9854	2.6692	1.6092	1.0448
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9551	1.0384	1.8677	8.5882
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0437	1.0323	1.3046	4.3294
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0928	0.9942	0.0771	0.5041
Sum of weighted rates:	4.0683	2.6897	1.7255	2.3823
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0225	1.0245	1.2166	1.8987
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0705	0.9866	0.6514	0.2211
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9796	0.9924	0.9326	0.4386

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Thyroid gland

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.4902	0.7535	0.1848	0.2463
Averaged 2nd order rate:	0.5173	0.7189	0.0345	0.1850
Averaged 3rd order rate:	0.3631	0.7252	0.3715	0.3964
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9476	1.0481	5.3565	1.3313
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.3500	1.0390	0.4974	0.6213
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.4247	0.9913	0.0929	0.4667
Sum of weighted rates:	0.4117	0.7318	0.2813	0.3284
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.1907	1.0296	0.6569	0.7500
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.2565	0.9824	0.1226	0.5633
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.8819	0.9910	1.3206	1.2086

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Endocrine organs

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.2856	0.2654	0.0775	0.0213
Averaged 2nd order rate:	0.2768	0.1577	0.0366	0.0506
Averaged 3rd order rate:	0.2667	0.1948	0.0515	0.0473
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0318	1.6829	2.1175	0.4209
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0709	1.3624	1.5048	0.4503
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0379	0.8095	0.7107	1.0698
Sum of weighted rates:	0.2726	0.2091	0.0611	0.0373
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0477	1.2692	1.2684	0.5710
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0154	0.7542	0.5990	1.3566
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9784	0.9316	0.8429	1.2681

Trends	White Males	White Females	Non-white Males	Non-white Females
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

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CANCER SITE: Bone

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	1.3432	0.8044	0.6826	0.2112
Averaged 2nd order rate:	1.4098	0.8390	6.5224	0.2964
Averaged 3rd order rate:	1.3313	0.8824	1.2662	0.9172
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9528	0.9588	0.1046	0.7125
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0089	0.9116	0.5391	0.2303
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0590	0.9508	5.1512	0.3232
Sum of weighted rates:	1.3424	0.8581	1.2890	0.6137
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0006	0.9374	0.5296	0.3441
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0502	0.9777	5.0600	0.4830
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9917	1.0283	0.9823	1.4945
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	184	X		

CANCER SITE: Connective tissue

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.5325	0.3985	0.3774	0.3912
Averaged 2nd order rate:	0.6488	0.5463	0.7038	0.2277
Averaged 3rd order rate:	0.6220	0.4597	0.3767	0.6883
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.8207	0.7294	0.5362	1.7180
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.8561	0.8660	1.0019	0.5684
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0431	1.1884	1.8683	0.3308
Sum of weighted rates:	0.6017	0.4528	0.3928	0.1530
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8850	0.8801	0.9608	2.5569
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0783	1.2065	1.7917	1.4482
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0337	1.0152	0.9590	4.4987

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Hodgkin's

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	2.2210	1.2231	1.0202	0.5785
Averaged 2nd order rate:	2.1782	1.2260	3.8701	0.2143
Averaged 3rd order rate:	2.2463	1.3215	0.7334	0.7158
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0196	0.9976	0.2636	2.6995
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.9887	0.9255	1.3910	0.8082
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.9697	0.9277	5.2769	0.2994
Sum of weighted rates:	2.2328	1.2867	0.9986	0.6399
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9947	0.9506	1.0216	0.9040
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9755	0.9528	3.8755	0.3349
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0060	1.0270	0.7344	1.1186
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

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CANCER SITE: Lymphosarcoma

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.9200	3.2943	11.3366	1.1738
Averaged 2nd order rate:	4.7684	3.2386	3.4169	1.4381
Averaged 3rd order rate:	4.6771	3.2264	1.4085	1.2652
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0318	1.0172	3.3178	0.8162
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0519	1.0210	8.0487	0.9278
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0195	1.0038	2.4259	1.1367
Sum of weighted rates:	4.7492	3.2350	5.4374	1.2371
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0360	1.0152	2.0849	0.9488
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0040	0.9980	0.6284	1.1625
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9848	0.9943	0.2590	1.0227
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Malignant Melanoma

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	1.6870	1.3077	1.3904	1.8647
Averaged 2nd order rate:	1.7778	1.1799	1.8585	0.7126
Averaged 3rd order rate:	1.7174	1.1641	1.5248	1.9614
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9489	1.1083	0.7481	2.6169
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.9822	1.1234	0.9119	0.9507
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0352	1.0136	1.2188	0.3633
Sum of weighted rates:	1.7157	1.2024	1.4877	1.8684
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9833	1.0876	0.9346	0.9980
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0362	0.9813	1.2492	0.3814
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0010	0.9681	1.0249	1.0498
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.		X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Leukemia

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	8.5566	5.5781	7.1985	2.7852
Averaged 2nd order rate:	8.6695	5.6443	8.4316	2.0768
Averaged 3rd order rate:	8.9543	5.8889	5.5888	2.9523
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.9870	0.9883	0.8527	1.3411
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.9556	0.9472	1.2225	0.9434
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.9682	0.9585	1.4319	0.7034
Sum of weighted rates:	8.8224	5.7848	6.3637	2.8482
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9699	0.9643	1.1312	0.9779
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9827	0.9757	1.3249	0.7292
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0149	1.0180	0.8782	1.0365
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X	X		

CANCER SITE: ICD's not listed

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	9.8353	9.4042	10.1293	12.4898
Averaged 2nd order rate:	9.5067	9.1145	5.0741	7.6560
Averaged 3rd order rate:	9.6726	9.4163	13.7322	1.3590
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0346	1.0318	1.9963	1.6314
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.0168	0.9981	0.7376	1.3345
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.9828	0.9679	0.3695	0.8180
Sum of weighted rates:	9.6976	0.3828	11.8870	10.5081
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0142	1.0023	0.8521	1.1886
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9803	0.9714	0.4269	0.1286
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9974	1.0036	1.1552	0.8906

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: All malignant neoplasms

☒ Urban and Rural Counties

☐ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	169.990	131.514	149.829	133.907
Averaged 2nd order rate:	161.980	127.931	140.887	148.075
Averaged 3rd order rate:	154.326	127.666	127.847	109.866
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.0494	1.0280	1.0635	0.9043
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.1015	1.0301	1.0869	1.2188
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.0496	1.0021	1.0220	1.3478
Sum of weighted rates:	159.155	128.677	142.739	120.956
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0681	1.0220	1.0497	1.1071
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0177	0.9942	0.9870	1.2242
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9697	0.9921	0.9657	0.9083
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Lip

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.3513	0.0095	------	------
Averaged 2nd order rate:	0.3959	0.0144	------	------
Averaged 3rd order rate:	0.3771	0.0292	0.2849	------
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.877	0.660	------	------
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.932	0.325	------	------
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.050	0.493	------	------
Sum of weighted rates:	0.3765	0.0246	0.2044	------
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9331	0.3862	------	------
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0515	0.5854	------	------
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0020	1.1870	1.3938	------
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	192	X		

CANCER SITE: Salivary Glands

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.4189	0.2349	0.0732	0.0780
Averaged 2nd order rate:	0.3303	0.1959	------	0.6875
Averaged 3rd order rate:	0.3952	0.2213	0.2094	0.3231
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.268	1.200	------	0.113
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.060	1.130	0.350	0.241
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.836	0.885	------	2.128
Sum of weighted rates:	0.3890	0.2194	0.1600	0.3435
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0769	1.0106	0.4575	0.2271
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.8491	0.8929	------	2.0014
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0159	1.0086	1.3088	0.9406

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Nasopharynx

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.2483	0.1020	0.1988	0.0232
Averaged 2nd order rate:	0.3191	0.0939	0.0403	------
Averaged 3rd order rate:	0.2683	0.0815	0.0656	0.0248
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.778	1.086	4.933	------
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.925	1.252	3.030	0.935
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.189	1.152	0.614	------
Sum of weighted rates:	0.2730	0.0858	0.0796	0.0210
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9095	1.1888	2.4975	1.1048
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.1689	1.0944	0.5063	------
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9828	0.9499	0.8241	1.1810

Trends

	White Males	White Females	Non-white Males	Non-white Females
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.		X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Tongue and Mouth

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	3.5841	0.9064	0.6546	0.3131
Averaged 2nd order rate:	3.2118	0.8769	1.6276	0.5354
Averaged 3rd order rate:	2.8988	0.7178	4.3316	1.6891
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.116	1.034	0.402	0.585
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.236	1.263	0.151	0.185
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.108	1.222	0.376	0.317
Sum of weighted rates:	3.034	0.7636	3.4376	1.3466
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.1827	1.1870	0.1904	0.2325
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0599	1.1484	0.4735	0.3976
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9566	0.9400	1.2601	1.2543
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.			X	

CANCER SITE: Esophagus

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.0135	0.9776	717575	0.7111
Averaged 2nd order rate:	3.1768	0.7710	4.3694	27.4450
Averaged 3rd order rate:	2.8908	0.7367	5.4566	0.5824
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.263	1.268	1.775	0.026
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.388	1.327	1.422	1.221
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.100	1.046	0.801	47.124
Sum of weighted rates:	3.0741	0.7715	5.6010	4.4352
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.3056	1.2671	1.5484	0.1603
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0334	0.9994	0.8721	6.1880
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9404	0.9549	1.0290	0.1313
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Stomach

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	19.3141	0.2747	24.0850	8.5759
Averaged 2nd order rate:	16.6741	7.6514	19.6415	14.9487
Averaged 3rd order rate:	14.2376	7.4825	12.9416	6.4664
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.158	1.212	1.226	0.574
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.356	1.240	1.861	1.326
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.171	1.022	1.518	2.312
Sum of weighted rates:	15.2290	7.7290	15.4279	7.9503
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.2682	1.2000	1.5611	1.0787
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0949	0.9900	1.2731	1.8803
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9349	0.9680	0.8388	0.8134
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X	X	
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Large Intestine

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	16.0514	16.4708	8.9946	16.1056
Averaged 2nd order rate:	15.8353	16.4945	10.9660	8.8441
Averaged 3rd order rate:	15.6321	16.8474	10.9501	15.4474
"Risk" ratio of Averaged 1st order rate / Averaged 2nd order rate:	1.014	0.998	0.820	1.821
"Risk" ratio of Averaged 1st order rate / Averaged 3rd order rate:	1.027	0.978	0.821	1.043
"Risk" ratio of Averaged 2nd order rate / Averaged 3rd order rate:	1.013	0.979	1.001	0.572
Sum of weighted rates:	15.7143	16.7508	10.6917	14.5894
"Weighted risk" ratio of Averaged 1st order rate / Sum of weighted rates:	1.0214	0.9833	0.8413	1.1039
"Weighted risk" ratio of Averaged 2nd order rate / Sum of weighted rates:	1.0077	0.9847	1.0256	0.6062
"Weighted risk" ratio of Averaged 3rd order rate / Sum of weighted rates:	0.9948	1.0058	1.0242	1.0588
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

CANCER SITE: Rectum

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	7.3843	4.6759	1.5363	2.6566
Averaged 2nd order rate:	7.7999	5.0243	0.5218	1.4953
Averaged 3rd order rate:	7.1967	4.6700	4.9940	3.0834
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.947	0.931	0.161	1.777
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.026	1.001	0.308	0.862
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.084	1.076	1.907	0.485
Sum of weighted rates:	7.3063	4.7207	5.2092	2.8014
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0107	0.9905	0.6509	0.9483
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0676	1.0643	1.8279	0.5338
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9850	0.9893	0.9587	1.1007

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Liver

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	5.1124	6.5919	6.2985	6.1691
Averaged 2nd order rate:	4.6267	6.0335	5.7708	5.0352
Averaged 3rd order rate:	4.7725	6.2999	5.5268	4.8811
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.105	1.092	1.091	1.225
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.071	1.046	1.140	1.264
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.969	0.958	1.044	1.032
Sum of weighted rates:	4.7950	6.2986	4.6661	5.0695
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0662	1.0466	1.1116	1.2169
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9649	0.9579	1.0185	0.9932
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9953	1.0002	0.9754	0.9628
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.			X	
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

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CANCER SITE: Pancreas

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	9.1222	6.0195	2.8699	11.4348
Averaged 2nd order rate:	8.8440	5.4865	5.1862	2.6449
Averaged 3rd order rate:	8.4038	5.4293	7.5443	3.7939
"Risk" ratio of Averaged 1st order rate / Averaged 2nd order rate:	1.031	1.097	0.553	4.323
"Risk" ratio of Averaged 1st order rate / Averaged 3rd order rate:	1.085	1.109	0.380	3.014
"Risk" ratio of Averaged 2nd order rate / Averaged 3rd order rate:	1.052	1.010	0.687	0.697
Sum of weighted rates:	8.5577	5.5111	6.5689	4.6169
"Weighted risk" ratio of Averaged 1st order rate / Sum of weighted rates:	1.0660	1.0922	0.4369	0.0874
"Weighted risk" ratio of Averaged 2nd order rate / Sum of weighted rates:	1.0334	0.9955	0.7895	0.5729
"Weighted risk" ratio of Averaged 3rd order rate / Sum of weighted rates:	0.9820	0.9852	1.1485	0.8217
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.			X	

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CANCER SITE: Nose and Middle Ear

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.3687	0.2280	0.3242	0.4860
Averaged 2nd order rate:	0.5410	0.1748	0.2900	0.2206
Averaged 3rd order rate:	0.4433	0.2276	0.2350	0.1769
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.682	1.304	1.118	2.203
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.832	1.002	1.380	2.747
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.220	0.768	1.234	1.247
Sum of weighted rates:	0.4477	0.2202	0.2551	0.2231
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8235	1.0354	1.2709	2.1784
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.2084	0.7938	1.1368	0.9888
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9902	1.0336	0.9212	0.7929
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.			X	
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Larynx

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	2.2497	0.1479	1.6788	0.0203
Averaged 2nd order rate:	1.8078	0.2092	1.8202	0.1791
Averaged 3rd order rate:	1.7166	0.1748	1.6019	0.9542
"Risk" ratio of Averaged 1st order rate / Averaged 2nd order rate:	1.244	0.707	0.922	0.113
"Risk" ratio of Averaged 1st order rate / Averaged 3rd order rate:	1.310	0.846	1.048	0.021
"Risk" ratio of Averaged 2nd order rate / Averaged 3rd order rate:	1.053	1.197	1.136	0.188
Sum of weighted rates:	1.7973	0.1763	1.6448	0.7228
"Weighted risk" ratio of Averaged 1st order rate / Sum of weighted rates:	1.2517	0.8389	1.0207	0.0281
"Weighted risk" ratio of Averaged 2nd order rate / Sum of weighted rates:	1.0058	1.1866	1.1066	0.2478
"Weighted risk" ratio of Averaged 3rd order rate / Sum of weighted rates:	0.9551	0.9915	0.9739	1.3201
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Trachea, Bronchus and Lung

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	31.3235	4.9250	26.4475	5.3389
Averaged 2nd order rate:	30.0740	5.0627	19.0065	2.9137
Averaged 3rd order rate:	28.0289	5.0978	26.6694	4.9340
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.042	0.973	1.323	1.832
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.118	0.966	0.992	1.082
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.073	0.993	0.750	0.590
Sum of weighted rates:	28.7382	5.0714	25.6432	4.6978
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0900	0.9711	1.0314	1.1365
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0465	0.9912	0.7798	0.6202
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9753	1.0052	1.0400	1.0503
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

CANCER SITE: Breast

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.2628	25.0697	0.2047	22.5271
Averaged 2nd order rate:	0.1778	24.9366	1.8365	28.2036
Averaged 3rd order rate:	0.2389	24.0034	0.2149	17.0904
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.478	1.005	0.111	0.799
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.100	1.044	0.952	1.318
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.744	1.039	8.546	1.650
Sum of weighted rates:	0.2333	24.2674	0.4557	19.3798
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.1264	1.0331	0.4492	1.1624
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.7621	1.0276	4.0301	1.4553
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0240	0.9891	0.4716	0.8819
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.		X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

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CANCER SITE: Cervix Uteri

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:		8.1718		14.5349
Averaged 2nd order rate:		7.7446		23.4777
Averaged 3rd order rate:		7.9294		9.1016
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:		1.055		0.619
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:		1.030		1.507
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:		0.977		2.580
Sum of weighted rates:		7.9335		11.8566
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:		1.0300		1.2259
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:		0.9762		1.9801
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:		0.9995		0.7676

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Corpus Uteri

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:		6.5272		11/6947
Averaged 2nd order rate:		6.8642		10.4828
Averaged 3rd order rate:		6.9039		8.9368
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:		0.951		1.116
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:		0.945		1.309
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:		0.994		1.173
Sum of weighted rates:		6.8515		0.5139
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:		0.9527		1.2292
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:		1.0018		1.1018
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:		1.0076		0.9393
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

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CANCER SITE: Ovary and Fallopian tubes

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:		8.0938		4.2110
Averaged 2nd order rate:		8.5943		5.7223
Averaged 3rd order rate:		8.3943		6.2791
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:		0.942		0.736
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:		0.964		0.671
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:		1.024		0.911
Sum of weighted rates:		8.3852		5.9324
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:		0.9652		0.7098
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:		1.0249		0.9646
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:		1.0011		1.0584

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Prostate

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	18.2882		15.0168	
Averaged 2nd order rate:	18.5279		14.7194	
Averaged 3rd order rate:	18.3156		21.4893	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.987		1.020	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.998		0.699	
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.012		0.685	
Sum of weighted rates:	18.3423		19.6153	
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9970		0.7656	
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0101		0.7504	
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9985		1.0955	

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Testis

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.9430		0.0286	
Averaged 2nd order rate:	0.8982		0.0236	
Averaged 3rd order rate:	0.9220		0.1907	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.050		1.213	
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.023		0.150	
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.974		0.124	
Sum of weighted rates:	0.9213		0.1441	
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0236		0.1984	
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9749		0.1638	
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0008		1.3232	

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Kidney

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.0716	2.1718	1.5582	0.3425
Averaged 2nd order rate:	3.5932	2.0285	2.3489	0.8401
Averaged 3rd order rate:	3.7473	2.0740	2.2447	1.7412
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.133	1.071	0.663	0.408
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.086	1.047	0.694	0.196
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.959	0.978	1.046	0.482
Sum of weighted rates:	3.7666	2.0796	2.1688	1.4318
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0810	1.0443	0.7185	0.2392
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9540	0.9754	1.0830	0.5867
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9949	0.9973	1.0350	1.2161

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Bladder

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	6.6565	2.4786	4.7320	1.6780
Averaged 2nd order rate:	7.2752	2.2722	5.2706	1.8197
Averaged 3rd order rate:	5.7923	2.1219	2.4443	2.6279
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.915	1.091	0.898	0.922
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.150	1.168	1.936	0.638
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.256	1.071	2.156	0.692
Sum of weighted rates:	6.1129	2.1874	3.1714	2.3898
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0889	1.1331	1.4921	0.7022
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.1901	1.0388	1.6619	0.7614
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9476	0.9700	0.7707	1.0996
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.		X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Skin Melanoma

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.9310	0.7607	0.0126	------
Averaged 2nd order rate:	0.9973	0.9125	0.0284	0.3851
Averaged 3rd order rate:	1.2169	0.9832	0.0651	0.3058
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.0934	0.834	0.444	-----
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.765	0.774	0.192	-----
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.820	0.928	0.432	1.259
Sum of weighted rates:	1.1493	0.9456	0.0531	0.2776
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8100	0.8045	0.2373	------
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.8677	0.9650	0.5348	1.3872
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0588	1.0398	1.2373	1.1016
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X	X	X	

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CANCER SITE: Other Skin

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	1.3156	0.5455	3.0772	0.0599
Averaged 2nd order rate:	1.3163	0.6192	1.0683	0.1171
Averaged 3rd order rate:	1.4493	0.6415	0.4698	0.4386
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.999	0.881	2.880	0.512
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.908	0.850	6.550	0.136
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.908	0.965	2.274	0.267
Sum of weighted rates:	1.4134	0.6265	0.9069	0.3438
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9308	0.8707	3.3931	0.1742
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9313	0.9883	1.1780	0.3406
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0254	1.0239	0.5180	1.2757
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.			X	
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X	X		

CANCER SITE: Eye

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.1859	0.1879	------	0.1579
Averaged 2nd order rate:	0.2100	0.1484	0.0286	------
Averaged 3rd order rate:	0.2392	0.1953	0.0087	0.1363
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.0885	1.266	-----	-----
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.777	0.962	-----	1.158
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.878	0.760	3.287	-----
Sum of weighted rates:	0.2283	0.1878	0.0106	0.1196
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8143	1.0005	------	1.3202
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9198	0.7902	2.6981	------
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0477	1.0399	0.8208	1.1396
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X			

CANCER SITE: Brain and Nervous system

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.0784	2.6748	2.0118	4.9574
Averaged 2nd order rate:	4.3283	2.6248	0.9971	0.4713
Averaged 3rd order rate:	3.9547	2.6556	1.5742	1.0169
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.942	1.019	2.018	10.518
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.031	1.007	1.278	4.875
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.094	0.988	0.633	0.463
Sum of weighted rates:	4.0235	2.6536	1.5464	1.4481
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0136	1.0080	1.3010	3.4234
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0758	0.9891	0.6448	0.3255
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9829	1.0008	1.0180	0.7022

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Thyroid gland

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.4758	0.7330	0.0365	0.1952
Averaged 2nd order rate:	0.5146	0.7144	0.0145	0.1366
Averaged 3rd order rate:	0.3514	0.7243	0.3741	0.3914
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.925	1.026	2.517	1.429
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.330	1.012	0.098	0.499
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.440	0.986	0.039	0.349
Sum of weighted rates:	0.3948	0.7240	0.2754	0.3296
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.2052	1.0124	0.1325	0.5922
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.3034	0.9867	0.0526	0.4144
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9053	1.0004	1.3584	1.1875

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Endocrine Organs

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.2758	0.2759	0.0440	------
Averaged 2nd order rate:	0.2757	0.1591	0.0272	0.0471
Averaged 3rd order rate:	0.2614	0.1941	0.0480	0.0427
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.000	1.734	1.618	-----
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.055	1.421	0.917	-----
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.055	0.820	0.567	1.103
Sum of weighted rates:	0.2653	0.1994	0.0444	0.0378
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0396	1.3836	0.9910	------
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0392	0.7979	0.6126	1.2460
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9853	0.9734	1.0811	1.1296
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X			
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Bone

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	1.3431	0.8122	0.5750	0.1433
Averaged 2nd order rate:	1.4135	0.8450	6.9115	0.2245
Averaged 3rd order rate:	1.3269	0.8821	1.2838	0.9112
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.950	0.961	0.083	0.638
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.012	0.921	0.448	0.157
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.065	0.958	5.384	0.246
Sum of weighted rates:	1.3412	0.8682	2.0297	0.7140
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0014	0.9355	0.2833	0.2007
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0539	0.9733	3.4052	0.3144
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9893	1.0160	0.6325	1.2762

Trends

	White Males	White Females	Non-white Males	Non-white Females
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

CANCER SITE: Connective Tissue

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	0.5190	0.3785	0.3568	0.3954
Averaged 2nd order rate:	0.6483	0.5478	0.7236	0.2246
Averaged 3rd order rate:	0.6191	0.4580	0.3638	0.6983
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.800	0.691	0.493	1.760
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.838	0.826	0.981	0.566
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.047	1.196	1.989	0.322
Sum of weighted rates:	0.6105	0.4608	0.4166	0.5915
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.8501	0.8214	0.8564	0.8581
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0619	1.1880	1.7369	0.3797
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0141	0.9939	0.8732	1.1806

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: Hodgkin's

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	2.1772	1.1993	0.9282	0.4193
Averaged 2nd order rate:	2.1638	1.2136	3.9428	0.1964
Averaged 3rd order rate:	2.2358	1.3145	0.7054	0.7189
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.006	0.988	0.235	2.135
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.984	0.912	1.316	0.583
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.968	0.923	5.589	0.273
Sum of weighted rates:	2.2182	1.2860	1.2186	0.6056
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9815	0.9326	0.7617	0.6924
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9755	0.9437	3.2355	0.3243
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0079	1.0222	0.5789	1.1871
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.		X		

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CANCER SITE: Lymphosarcoma

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	4.8484	3.2486	12.5699	1.0770
Averaged 2nd order rate:	4.7359	3.1958	3.3140	1.3418
Averaged 3rd order rate:	4.6538	3.2166	1.2497	1.2338
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.024	1.016	3.793	0.803
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.042	1.010	10.058	0.873
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.018	0.994	2.652	1.088
Sum of weighted rates:	4.6902	3.2176	3.0673	1.2290
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0337	1.0096	4.0980	0.8763
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0097	0.9932	1.0804	1.0918
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9922	0.9997	0.4074	1.0039
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X		X	
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: ICD's not listed

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	9.6478	9.3665	0.7299	12.5807
Averaged 2nd order rate:	9.3495	9.0721	4.3872	7.3556
Averaged 3rd order rate:	9.5897	9.4003	13.7450	9.1978
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.032	1.032	2.218	1.710
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.006	1.036	0.708	1.368
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.975	0.965	0.319	0.800
Sum of weighted rates:	9.5629	9.3498	11.8121	9.3718
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	1.0089	1.0018	0.8237	1.3424
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9777	0.9703	0.3714	0.7849
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0028	1.0054	1.1636	0.9814

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

CANCER SITE: All Malignant Neoplasms

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	165.7077	130.0746	140.1987	131.4023
Averaged 2nd order rate:	160.4561	127.3310	135.1143	148.4828
Averaged 3rd order rate:	152.8577	127.1617	134.2927	108.0597
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	1.033	1.022	1.038	0.885
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	1.084	1.023	1.044	1.216
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.050	1.001	1.006	1.374
Sum of weighted rates:		127.5475	135.2029	116.8480
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:		1.0198	1.0370	1.1246
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:		0.9983	0.9993	1.2707
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:		0.9970	0.9933	0.9248
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.	X	X		
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.				

CANCER SITE: Leukemia

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	8.4749	5.5223	7.3336	2.6525
Averaged 2nd order rate:	8.6284	5.6000	8.5000	1.9077
Averaged 3rd order rate:	8.9641	5.8911	5.6001	2.8737
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.982	0.986	0.863	1.390
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.945	0.937	1.310	0.923
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	0.962	0.950	1.518	0.664
Sum of weighted rates:	8.8542	5.8042	6.2643	2.7072
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9572	0.9514	1.1707	0.9798
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	0.9745	0.9648	1.3569	0.7047
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	1.0124	1.0150	0.8940	1.0615
Trends				
The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.				
The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.	X	X		

CANCER SITE: Multiple Myeloma

☐ Urban and Rural Counties

☒ Rural Counties (counties having urban centers with 100,000 inhabitants are excluded from analysis.)

	White Males	White Females	Non-white Males	Non-white Females
Averaged 1st order rate:	1.6703	1.2923	1.0636	1.8625
Averaged 2nd order rate:	1.7654	1.1488	1.7415	0.5793
Averaged 3rd order rate:	1.7115	1.1624	1.4088	1.9602
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 2nd order rate}}$:	0.946	1.125	0.611	3.217
"Risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Averaged 3rd order rate}}$:	0.976	1.112	0.755	0.950
"Risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Averaged 3rd order rate}}$:	1.031	0.988	1.236	0.296
Sum of weighted rates:	1.7139	1.1766	1.4124	1.7504
"Weighted risk" ratio of $\frac{\text{Averaged 1st order rate}}{\text{Sum of weighted rates}}$:	0.9746	1.0983	0.9402	1.0640
"Weighted risk" ratio of $\frac{\text{Averaged 2nd order rate}}{\text{Sum of weighted rates}}$:	1.0300	0.9764	1.2330	0.3310
"Weighted risk" ratio of $\frac{\text{Averaged 3rd order rate}}{\text{Sum of weighted rates}}$:	0.9986	0.9879	0.9974	1.1198

Trends

The averaged first order rate is greater than the second order rate which in turn is greater than the third order rate.

The averaged third order rate is greater than the second order rate which in turn is greater than the first order rate.

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APPENDIX II

Study Questionnaires and Survey Instruments
for the Study of Great Lakes Commercial Fishermen

- Telephone interview questionnaire (pilot) Protocols 1 and 2
- mailed questionnaire (pilot) Protocol 3
- telephone proxy questionnaire (Pilot)
- Great Lakes Fishermen Health Survey - Large Cohort

Telephone Interview (Protocols 1 and 2)

FISHERMEN HEALTH SURVEY

INSTRUCTIONS: Please answer the following questions and return the questionnaire within five days. Use the enclosed stamped, self-addressed envelope for mailing. Your answers are confidential and will only be used for research purposes. Your identity will not be associated with the survey results.

If you cannot give an exact answer, provide your best estimate.

1. What is your current address? ______________________________
(street)
______________________ ____________ ________
(city) (state) (zip)

---

2. What is your sex? 1) ○ Male 2) ○ Female
3. What is your race? 1) ○ White 2) ○ Black 3) ○ Hispanic 4) ○ American Indian 5) ○ Other
4. What is your birthdate? ________ / ____ / ________
month day year
5. What is your Social Security number? ________ - ______ - ________
6. What is your marital status? 1) ○ Single (never married) 2) ○ Married 3) ○ Separated or divorced 4) ○ Widowed
7. Do you presently hold a commercial fishing license? 1) ○ No 2) ○ Yes → Approximately over what years have you held a license? ____ / ____
from to
(go to question 10)
8. Did you hold a commercial fishing license in the past? 1) ○ No 2) ○ Yes → Approximately over what years did you hold a license? ____ / ____
from to
(go to question 10)

9. Have you ever been a crew member for, or a partner with, an individual owning a commercial fishing license?

1) ○ No   2) ○ Yes ⟶ Over what years have you been a crew member or partner _____/_____ (go to question 10)

from   to

(If No, please stop here and return the questionnaire as soon as possible in the addressed envelope. Thank you for your cooperation.)

0. Near what towns do (did) you commercially fish most often?

____

____

____

____

____

____

____

____

0a. Where is (was) your home port located?

____

City   State

12. What is your current full-time occupation? ______________________________

1. Is commercial fishing your current full-time occupation? 1) ○ No → 13. Was commercial fishing ever your full time occupation?

1) ○ No → Over what years have you been a part-time fisherman? _____/_____ (from / to) (go to question 14)

2) ○ Yes → Over what years were you full time? _____/_____ (from / to)

2) ○ Yes → Over what years have you commercially fished full time? _____/_____ (from / to) (go to question 14)

4. Do you currently own a sport fishing license? 1) ○ No (go to question 15) 2) ○ Yes (go to question 16)

5. Have you ever owned a sport fishing license? 1) ○ No (go to question 17) 2) ○ Yes (go to question 16)

6. Near what towns do (did) you sport fish most often?

____
____
____
____
____
____
____
____
____
____

. To the best of your knowledge, tell me the names and addresses of full or part-time crew members? (past and present)

me	Street	City	State	Zip	Employed From	To

. Do (or did) you consume any of the fish you catch commercially or as a sport fisherman? 2) ○ Yes . 1) ○ No (If No, go to question 28)

. Approximately how many of your meals contain fish caught (by yourself or a friend) from the Great Lakes?

1) _____per week (or) 2)_____per month

. What types of Great Lakes fish do you eat most often?

_____Salmon _____Walleye _____Rough fish _____Northern Pike _____Lake Trout _____Bass _____Pan fish _____Other Trout

_____Perch _____Burbot _____Chub _____Lake Whitefish _____Smelt _____Lake Herring _____Other: (specify)_____________

. Approximately how many years have you consumed Great Lakes fish with this frequency? _____years

. Approximately how many of your meals contain fish caught (by yourself or a friend) from waters other than the Great Lakes?

1) _____per week (or) 2) _____per month

3. What types of "other inland waters" fish do you eat most often?

_____Salmon _____Walleye _____Rough fish _____Northern Pike _____Lake Trout _____Bass _____Pan fish _____Other Trout

_____Perch _____Burbot _____Chub _____Lake Whitefish _____Smelt _____Lake Herring _____Other: (specify)____________________

24. Approximately how many years have you consumed inland water fish with this frequency? _______years

25. In comparison to yourself: How often does your wife eat fish? How often do your sons eat fish? How often do your daughters eat fish?

Wife:	Sons:	Daughters:
1) ○ As often as myself	1) ○ As often as myself	1) ○ As often as myself
2) ○ More often than myself	2) ○ More often than myself	2) ○ More often than myself
3) ○ Less often than myself	3) ○ Less often than myself	3) ○ Less often than myself
4) ○ Does not apply	4) ○ Does not apply	4) ○ Does not apply
5) ○ Never	5) ○ Never	5) ○ Never

26. Approximately how many pounds of fish have you consumed per year?

(assume: 1 fish meal equals ½ pound of fish) _______pounds

27. Of the fish you catch and consume, what percentage of the fish are prepared by each of the following methods?

1) Broiling ______%
2) Pan frying ______%
3) Smoked ______%
4) Boiling ______%
5) Poached ______%
6) Other ______%

28. Do you presently smoke cigarettes? 1) ○ No 2) ○ Yes → 30.

29. How old were you when you first began to smoke cigarettes? ____

30. What is the average number of cigarettes you presently smoke per day? ____

31. How many years have you smoked cigarettes wath this frequency? ____
(go to question 34)

28a. Did you smoke cigarettes in the past? 1) ○ No 2) ○ Yes → 33.
(go to question 34)

32. How old were you when you first began to smoke cigarettes? ____

33. How many years did you smoke cigarettes? ____
(go to question 34)

34. Do you presently smoke a pipe? 1) ○ No 2) ○ Yes

35. How old were you when you first began to smoke a pipe? ________

36. What is the average number of pipefuls you presently smoke per day? ________

37. How many years have you smoked a pipe with this frequency? ________

(go to question 40)

34a. Did you smoke a pipe in the past? 1) ○ No 2) ○ Yes

(If No, go to question number 40)

38. How old were you when you first began to smoke a pipe? ________

39. How many years did you smoke a pipe? ________

(go to question 40)

40. Do you presently smoke cigars? 1) ○ No 2) ○ Yes →

41. How old were you when you began to smoke cigars? ________

42. What is the average number of cigars you presently smoke per day? ________

43. How many years have you smoked cigars with this frequency? ________

(go to question 46)

40a. Did you smoke cigars in the past 1) ○ No 2) ○ Yes →

(If No, go to question number 46)

44. How old were you when you began to smoke cigars? ________

45. How many years did you smoke cigars? ________

(go to question 46)

46. Have you ever chewed tobacco regularly? 1) ○ No 2) ○ Yes

47. Have you ever used snuff regularly? 1) ○ No 2) ○ Yes

48. Have you ever smoked non-tobacco products regularly? 1) ○ No 2) ○ Yes

Hard liquor is considered to include: Gin; Whiskey; Scotch; Vodka; Rum; Brandy

(A drink = 1 to 1½ oz. of alcohol.)

49. Do you drink hard liquors? 1) ○ No 2) ○ Yes →

50. How old were you when you first began to drink hard liquors? ______

51. What is the average number of hard liquor drinks you consume per week? ______

52. How many years have you consumed hard liquor with this frequency? ______

49a. Did you consume hard liquors in the past? 1) ○ No 2) ○ Yes →

(go to question 55)

53. How old were you when you first began to drink hard liquor? ______

54. How many years did you consume hard liquor? ______

(go to question 55)

55. Do you drink beer? 1) ○ No 2) ○ Yes →

56. How old were you when you first began to drink beer? ____

57. What is the average number of beers (12 oz. bottles) you presently consume per week? ____

58. How many years have you consumed beer with this frequency? ____

(go to question 61)

55a. Did you drink beer in the past? 1) ○ No 2) ○ Yes →

(go to question 61)

59. How old were you when you first began to drink beer? ____

60. How many years did you consume beer? ____

(go to question 61)

61. Do you drink wine? 1) ○ No 2) ○ Yes

62. How old were you when you first began to drink wine? ______

63. What is the average number of wine drinks you have per week? ______

64. How many years have you consumed wine with this frequency? ______

(go to question 67)

61a. Did you drink wine in the past? 1) ○ No 2) ○ Yes

(go to question 67)

65. How old were you when you first began to drink wine? ______

66. How many years did you consume wine? ______

(go to question 67)

Have you, your wife, or any of your children ever had any of the following diseases or conditions. (Please check appropriate box.)

67. Asthma 1) ○ No 2) ○ Yes

68. Bronchitis 1) ○ No 2) ○ Yes

69. Emphysema 1) ○ No 2) ○ Yes

70. Tuberculosis- TB 1) ○ No 2) ○ Yes

71. Mononucleosis-Mono-Kissing Disease 1) ○ No 2) ○ Yes

72. Pneumonia 1) ○ No 2) ○ Yes

73. Any other disease of the respiratory system Specify:________________ 1) ○ No 2) ○ Yes

74. Hepatitis or yellow jaundice 1) ○ No 2) ○ Yes

75. Cirrhosis 1) ○ No 2) ○ Yes

76. Any other liver disease Specify:________________ 1) ○ No 2) ○ Yes

77. Spondylitis 1) ○ No 2) ○ Yes

78. Gout 1) ○ No 2) ○ Yes

79. Rheumatoid Arthritis 1) ○ No 2) ○ Yes

80. Osteoarthritis 1) ○ No 2) ○ Yes

81. Any other diseases of bones and joints Specify:________________ 1) ○ No 2) ○ Yes

82. High triglycerides 1) ○ No 2) ○ Yes

83. Meningitis 1) ○ No 2) ○ Yes

84. Hypertension or high blood pressure 1) ○ No 2) ○ Yes

85. High cholesterol 1) ○ No 2) ○ Yes

86. Angina pectoris 1) ○ No 2) ○ Yes

87. Heart attach-MI or coronary 1) ○ No 2) ○ Yes

88. Stroke, cerebral accident, (CVA)-hemorrhage, thrombosis, embolism 1) ○ No 2) ○ Yes

89. Any other heart or circulatory disease Specify:________ 1) ○ No 2) ○ Yes

90. Diabetes 1) ○ No 2) ○ Yes

91. Thyroiditis 1) ○ No 2) ○ Yes

92. Any other glandular disorder Specify:________________ 1) ○ No 2) ○ Yes

93. Eye diseases Specify:________________ 1) ○ No 2) ○ Yes

94. Psoriasis 1) ○ No 2) ○ Yes

95. Eczema 1) ○ No 2) ○ Yes

96. Herpes zoster-shingles (dermatitis) 1) ○ No 2) ○ Yes

97. Pemphigus 1) ○ No 2) ○ Yes

98. Any other diseases of skin Specify:________________ 1) ○ No 2) ○ Yes

99. Multiple Sclerosis 1) ○ No 2) ○ Yes

100. Any other diseases of the nervous system
Specify:________________ 1) ○ No 2) ○ Yes

101. Anemia 1) ○ No 2) ○ Yes

102. Gastritis 1) ○ No 2) ○ Yes

103. Ulcers (stomach or duodenal) 1) ○ No 2) ○ Yes

104. Any other diseases of the digestive system
Specify:________________ 1) ○ No 2) ○ Yes

105. Cancer of the breast 1) ○ No 2) ○ Yes

106. Cancer of the stomach 1) ○ No 2) ○ Yes

107. Cancer of the esophagus 1) ○ No 2) ○ Yes

108. Cancer of the mouth/tongue 1) ○ No 2) ○ Yes

109. Cancer of the large intestine 1) ○ No 2) ○ Yes

110. Cancer of the rectum 1) ○ No 2) ○ Yes

111. Cancer of the trachea, bronchus or lung 1) ○ No 2) ○ Yes

112. Cancer of the liver or biliary passage 1) ○ No 2) ○ Yes

113. Cancer of the bladder or urinary organs 1) ○ No 2) ○ Yes

114. Cancer of the skin 1) ○ No 2) ○ Yes

115. Cancer of the thyroid 1) ○ No 2) ○ Yes

116. Leukemia 1) ○ No 2) ○ Yes

117. Other cancer
Specify:________________ 1) ○ No 2) ○ Yes

118. Mental retardation 1) ○ No 2) ○ Yes

For each of the diseases you have mentioned in your family members, please tell me:

Name of disease/condition ______________________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

Name of disease/condition ______________________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

For each of the diseases you have mentioned in your family members, please tell me:

Name of disease/ condition ____________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

Name of disease/ condition ____________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

For each of the diseases you have mentioned in your family members, please tell me:

Name of disease/condition ____________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

Name of disease/condition ____________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

For each of the diseases you have mentioned in your family members, please tell me:

Name of disease/condition ______________________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

Name of disease/condition ______________________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

For each of the diseases you have mentioned in your family members, please tell me:

Name of disease/condition ____________________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

Name of disease/condition ____________________

Names of family members who have the disease/condition:	Names and addresses of the clinics, hospitals, or doctors consulted:	Date of diagnosis:

Have you ever had any of the following symptoms?			How frequently does (or did) this occur? (days, months, or years)	How long do (or did) the symptoms last? (days, months, or years)	Did you consult a doctor?			Year most recently experienced
	No	Yes			No	Yes	Doctor's name & address	
119. Severe fever								
120. Extreme tiredness								
121. Frequent or very bad headaches								
122. Problems with mouth or throat								
123. Any problems with ears or hearing Specify:______								
124. Any unusual difficulty with eyes or eyesight other than a change of the prescription of glasses? Specify:______								
125. Sudden weakness or heaviness of arms or legs? Specify:______								
126. Numbness in arms or legs?								
127. Swelling in arms or legs?								
128. Stiffness in joints or bones? Specify:______								
129. Pains in joints or bones? Specify:______								
130. Spasms of limbs?								
131. Spells of dizziness?								
132. Have you fainted or blacked out?								
133. Very strong heartbeats?								
134. Irregular (fast, slow or inconstant) heartbeats?								

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Have you ever had any of the following symptoms?			How frequently does (or did) this occur? (days, months, or years)	How long do (or did) the symptoms last? (days, months, or years)	Did you consult a doctor?		Doctor's name & address	Year most recently experienced
	No	Yes			No	Yes		
135. Have you had pain, discomfort, or trouble in or around your heart?								
136. Itching of the skin?								
137. Any unusual discoloration or eruptions on the skin? Specify:__________								
138. Any problems with your stomach or digestive system? Specify:__________								
139. Swollen glands in your neck, armpits or groin?								
140. Have you lost 20 or more pounds in the last five years? (include dieting)								

THE LAST SECTION OF THE QUESTIONNAIRE RELATES TO YOUR WIFE AND CHILDREN. IF I MAY SPEAK TO YOUR WIFE, SHE MAY BE ABLE TO ANSWER THE FEW QUESTIONS REMAINING.

141. How many natural children do you have? ________

How many step or adopted children do you have? ________

Please tell me of all pregnancies and outcomes of which you were the father/mother in the sequence they occured.

Preg. #	Complications in this pregnancy (describe)	Outcome				Infants sex		Date of Birth	Live Birth Weight	Hospital, clinic or place of birth	Doctor's name
		Miscarriage	Stillbirth	Live Birth	Other	M	F				
1.											
2.											
3.											
4.											
5.											
6.											

141a. Have any of your natural children died? (do not include stillbirths nor step or adopted children)

1) No 2) Yes (If Yes, please complete the following table.)

	Sex		Date of Birth	Date of Death	Cause of Death	City and State in which death was reported
	M	F				
1.						
2.						
3.						
4.						

142. Do you know of any mental or physical abnormalities at birth (birth defects) in yourself or your natural children.

1) ○ No 2) ○ Yes (If Yes, please complete the following table.)

↓ (go to question 143)

	Relationship to you			(Check appropriate boxes)		
	Self	Son	Daughter	Living	Dead	Nature of Birth Defect (describe)
1.						
2.						
3.						
4.						

143. Do you use a birth control method? 1) ○ No (go to question 146) 2) ○ Yes (If Yes, answer questions 144 and 145)

144. What method of birth control have you used the most during your adult life?
1) ○ pill 2) ○ IUD 3) ○ diaphragm 4) ○ foam or jelly 5) ○ rhythm 6) ○ condom 7) ○ other (specify): ______

145. At what age did you begin using birth control methods? ______________

146. At what age did you begin to menstruate? ______________

146a. Have you stopped menstruating? 1) ○ No (If No, go to question 149) 2) ○ Yes

147. At what age did you stop menstruating? ______

148. Did the cessation occur naturally or due to surgery?
1) ○ Naturally 2) ○ Surgery ⟶ What was the reason for the surgery? ______________________________
Doctor's name and address? ______________________________
name address

149. What is (was) the average length of your menstrual cycle? ______ days (From first day of bleeding to first day of next period)

150. On the average, how long is (was) your period? ______ days

151. In the past five years, has your blood flow during menstruation 1) ○ increased? 2) ○ decreased? 3) ○ stayed the same?

152. Have (or did) you experience any abnormal spotting or bleeding between your menstrual cycles? 1) ○ No (go to question 154) 2) ○ Yes (go to question 153)

153. If yes, did you consult a physician? 1) ○ No 2) ○ Yes Doctor's name & address ______________________________
name address

154. Have you used, or did you use, any medications prescribed by a doctor for menstrual irregularities?
1) ○ No 2) ○ Yes ⟶ Name of medication ______________________________

Questions 1-140 have been answered by ______________________________

Questions 141-153 have been answered by ______________________________

Thank you for your cooperation in this health survey. Please sign the consent form and return the questionnaire in the enclosed self-addressed stamped envelope.

Mailed Questionnaire (Protocol 3)

FISHERMEN HEALTH SURVEY

INSTRUCTIONS: Please answer the following questions and return the questionnaire within five days. Use the enclosed stamped, self-addressed envelope for mailing. Your answers are confidential and will only be used for research purposes. Your identity will not be associated with the survey results.

If you cannot give an exact answer, provide your best estimate.

1. What is your current address? ______________________ (street)
   ______________ (city) ________ (state) ______ (zip)

---

2. What is your sex? 1) ○ Male 2) ○ Female
3. What is your race? 1) ○ White 2) ○ Black 3) ○ Hispanic 4) ○ American Indian 5) ○ Other
4. What is your birthdate? ________/____/________ (month / day / year)
5. What is your Social Security number? ________ - ______ - ________
6. What is your marital status? 1) ○ Single (never married) 2) ○ Married 3) ○ Separated or divorced 4) ○ Widowed
7. Do you presently hold a commercial fishing license? 1) ○ No 2) ○ Yes → Approximately over what years have you held a license? _____/_____ (from / to) (go to question 10)
8. Did you hold a commercial fishing license in the past? 1) ○ No 2) ○ Yes → Approximately over what years did you hold a license? _____/_____ (from / to) (go to question 10)

9. Have you ever been a crew member for, or a partner with, an individual owning a commercial fishing license?

1) ○ No 2) ○ Yes ⟶ Over what years have you been a crew member or partner? ____/____ (go to question 10)

from to

↓

(If No, please stop here and return the questionnaire as soon as possible in the addressed envelope. Thank you for your cooperation.)

10. Indicate with an "X" on the encolsed map where you commercially fished most often. (You may indicate more than one location).

11. Is commercial fishing your current full-time occupation? 1) ○ No ⟶

12. What is your current full-time occupation? ____________________

13. Was commercial fishing ever your full time occupation?

1) ○ No ⟶ Over what years have you been a part-time fisherman? ____/____

from to

(go to question 14)

2) ○ Yes ⟶ Over what years were you full time? ____/____ (go to question 14)

from to

2) ○ Yes ⟶ Over what years have you commercially fished full time? ____/____

from to

(go to question 14)

14. Do you currently own a sport fishing license? 1) ○ No (go to question 15) 2) ○ Yes (go to question 16)

15. Have you ever owned a sport fishing license? 1) ○ No (go to question 17) 2) ○ Yes (go to question 16)

16. Indicate with an "O" on the enclosed map where you sport fish(ed) most often. (You may indicate more than one location.)

17. To the best of your knowledge, please list the names and addresses of full or part-time crew members? (past and present)

					Employed	
Name	Street	City	State	Zip	From	To

18. Do (or did) you consume any of the fish you catch commercially or as a sport fisherman? 1) ○ Yes 2) ○ No (If No, to to question 28)

19. Approximately how many of your meals contain fish caught (by yourself or a friend) from the Great Lakes?
1) _____per week (or) 2) _____per month

20. How many of those meals include the following types of fish:
_____Salmon _____Walleye _____Rough fish _____Northern Pike _____Lake Trout _____Bass _____Pan fish _____Other Trout
_____Perch _____Burbot _____Chub _____Lake Whitefish _____Smelt _____Lake Herring _____Other: (specify)__________

21. Approximately how many years have you consumed Great Lakes fish with this frequency? _______years

22. Approximately how many of your meals contain fish caught (by yourself or a friend) from waters other than the Great Lakes?
1) _____per week (or) 2) _____per month

23. How many of those meals contain the following types of fish?
______Salmon ______Walleye ______Rough Fish ______Northern Pike ______Lake Trout ______Bass ______Pan Fish
______Other Trout ______Perch ______Burbot ______Chub ______Lake Whitefish ______Smelt ______Lake Herring ______Other: _________
specify

24. Approximately how many years have you consumed inland water fish with this frequency?_________years

25. How often do your family members eat fish?

Wife:	**Sons:**	**Daughters:**
1) ○ As often as myself	1) ○ As often as myself	1) ○ As often as myself
2) ○ More often than myself	2) ○ More often than myself	2) ○ More often than myself
3) ○ Less often than myself	3) ○ Less often than myself	3) ○ Less often than myself
4) ○ Does not apply	4) ○ Does not apply	4) ○ Does not apply
5) ○ Never	5) ○ Never	5) ○ Never

26. Approximately how many pounds of fish have you consumed per year?
(assume: 1 fish meal equals ½ pound of fish) ______pounds

27. What percentages of fish you catch and consume are prepared by the following methods:

1) Broiling _____%
2) Pan frying _____%
3) Smoked _____%
4) Boiling _____%
5) Poached _____%
6) Other _____%

28. Do you presently smoke cigarettes? 1) ○ No 2) ○ Yes →

29. How old were you when you first began to smoke cigarettes? _____

30. What is the average number of cigarettes you presently smoke per day? _____

31. How many years have you smoked cigarettes with this frequency? _____
(go to question 34)

28a. Did you smoke cigarettes in the past? 1) ○ No 2) ○ Yes →
(go to question 34)

32. How old were you when you first began to smoke cigarettes? _____

33. How many years did you smoke cigarettes? _____
(go to question 34)

34. Do you presently smoke a pipe? 1) ○ No 2) ○ Yes

35. How old were you when you first began to smoke a pipe?________

36. What in the average number of pipefuls you presently smoke per day?____

37. How many years have you smoked a pipe with this frequency? ________

(go to question 40)

34a. Did you smoke a pipe in the past? 1) ○ No 2) ○ Yes

(If No, go to question number 40)

38. How old were you when you first began to smoke a pipe? ________

39. How many years did you smoke a pipe? ________

(go to question 40)

40. Do you presently smoke cigars? 1) ○ No 2) ○ Yes →

41. How old were you when you began to smoke cigars? ________

42. What is the average number of cigars you presently smoke per day? ________

43. How many years have you smoked cigars with this frequency? ________
(go to question 46)

40a. Did you smoke cigars in the past 1) ○ No 2) ○ Yes →
(If No, go to question number 46)

44. How old were you when you began to smoke cigars? ________

45. How many years did you smoke cigars? ________
(go to question 46)

46. Have you ever chewed tobacco regularly? 1) ○ No 2) ○ Yes
47. Have you ever used snuff regularly? 1) ○ No 2) ○ Yes
48. Have you ever smoked non-tobacco products regularly? 1) ○ No 2) ○ Yes

Hard liquor is considered to include: Gin; Whiskey; Scotch; Vodka; Rum; Brandy
(A drink = 1 to 1½ oz. of alcohol.)

49. Do you drink hard liquors? 1) ○ No 2) ○ Yes

50. How old were you when you first began to drink hard liquors? _____

51. What is the average number of hard liquor drinks you consume per week? _____

52. How many years have you consumed hard liquor with this frequency? _____

49a. Did you consume hard liquors in the past? 1) ○ No 2) ○ Yes
(go to question 55)

53. How old were you when you first began to drink hard liquor? _____

54. How many years did you consume hard liquor? _____
(go to question 55)

55. Do you drink beer? 1) ○ No 2) ○ Yes

56. How old were you when you first began to drink beer? ____

57. What is the average number of beers (12 oz. bottles) you presently consume per week? ____

58. How many years have you consumed beer with this frequency? ____

(go to question 61)

55a. Did you drink beer in the past? 1) ○ No 2) ○ Yes

(go to question 61)

59. How old were you when you first began to drink beer? ____

60. How many years did you consume beer? ____

(go to question 61)

61. Do you drink wine? 1) ○ No 2) ○ Yes

62. How old were you when you first began to drink wine? ______

63. What is the average number of wine drinks you have per week? ______

64. How many years have you consumed wine with this frequency? ______

(go to question 67)

61a. Did you drink wine in the past? 1) ○ No 2) ○ Yes

(go to question 67)

65. How old were you when you first began to drink wine? ______

66. How many years did you consume wine? ______

(go to question 67)

Have you, your wife, or any of your children ever had any of the following diseases or conditions. (Please check appropriate box.)

67. Asthma 1) ○ No 2) ○ Yes

68. Bronchitis 1) ○ No 2) ○ Yes

69. Emphysema 1) ○ No 2) ○ Yes

70. Tuberculosis- TB 1) ○ No 2) ○ Yes

71. Mononucleosis-Mono-Kissing Disease 1) ○ No 2) ○ Yes

72. Pneumonia 1) ○ No 2) ○ Yes

73. Any other disease of the respiratory system Specify:________________ 1) ○ No 2) ○ Yes

74. Hepatitis or yellow jaundice 1) ○ No 2) ○ Yes

75. Cirrhosis 1) ○ No 2) ○ Yes

76. Any other liver disease Specify:________________ 1) ○ No 2) ○ Yes

77. Spondylitis 1) ○ No 2) ○ Yes

78. Gout 1) ○ No 2) ○ Yes

79. Rheumatoid Arthritis 1) ○ No 2) ○ Yes

80. Osteoarthritis 1) ○ No 2) ○ Yes

81. Any other diseases of bones and joints Specify:________________ 1) ○ No 2) ○ Yes

82. High triglycerides 1) ○ No 2) ○ Yes

83. Meningitis 1) ○ No 2) ○ Yes

84. Hypertension or high blood pressure 1) ○ No 2) ○ Yes

85. High cholesterol 1) ○ No 2) ○ Yes

86. Angina pectoris 1) ○ No 2) ○ Yes

87. Heart attach-MI or coronary 1) ○ No 2) ○ Yes

88. Stroke, cerebral accident, (CVA)-hemorrhage, thrombosis, embolism 1) ○ No 2) ○ Yes

89. Any other heart or circulatory disease Specify:________ 1) ○ No 2) ○ Yes

90. Diabetes 1) ○ No 2) ○ Yes

91. Thyroiditis 1) ○ No 2) ○ Yes

92. Any other glandular disorder Specify:________________ 1) ○ No 2) ○ Yes

93. Eye diseases Specify:________________ 1) ○ No 2) ○ Yes

94. Psoriasis 1) ○ No 2) ○ Yes

95. Eczema 1) ○ No 2) ○ Yes

96. Herpes zoster-shingles (dermatitis) 1) ○ No 2) ○ Yes

97. Pemphigus 1) ○ No 2) ○ Yes

98. Any other diseases of skin Specify:________________ 1) ○ No 2) ○ Yes

99. Multiple Sclerosis 1) ○ No 2) ○ Yes

100.	Any other diseases of the nervous system Specify:________________	1) ○ No	2) ○ Yes
101.	Anemia	1) ○ No	2) ○ Yes
102.	Gastritis	1) ○ No	2) ○ Yes
103.	Ulcers (stomach or duodenal)	1) ○ No	2) ○ Yes
104.	Any other diseases of the digestive system Specify:________________	1) ○ No	2) ○ Yes
105.	Cancer of the breast	1) ○ No	2) ○ Yes
106.	Cancer of the stomach	1) ○ No	2) ○ Yes
107.	Cancer of the esophagus	1) ○ No	2) ○ Yes
108.	Cancer of the mouth/tongue	1) ○ No	2) ○ Yes
109.	Cancer of the large intestine	1) ○ No	2) ○ Yes
110.	Cancer of the rectum	1) ○ No	2) ○ Yes
111.	Cancer of the trachea, bronchus or lung	1) ○ No	2) ○ Yes
112.	Cancer of the liver or biliary passage	1) ○ No	2) ○ Yes
113.	Cancer of the bladder or urinary organs	1) ○ No	2) ○ Yes
114.	Cancer of the skin	1) ○ No	2) ○ Yes
115.	Cancer of the thyroid	1) ○ No	2) ○ Yes
116.	Leukemia	1) ○ No	2) ○ Yes
117.	Other cancer Specify:________________	1) ○ No	2) ○ Yes
118.	Mental retardation	1) ○ No	2) ○ Yes

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/ condition

____

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/ condition

____

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/ condition

____

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/ condition

____

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/ condition

____

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/ condition

____

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/condition ____________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/condition ____________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/ condition ____________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/ condition ____________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Have you ever had any of the following symptoms?			How frequently does (or did) this occur? (days, months, or years)	How long do (or did) the symptoms last? (days, months, or years)	Did you consult a doctor?		Doctor's name & address	Year most recently experienced
	No	Yes			No	Yes		
119. Severe fever								
120. Extreme tiredness								
121. Frequent or very bad headaches								
122. Problems with mouth or throat								
123. Any problems with ears or hearing Specify:________								
124. Any unusual difficulty with eyes or eyesight other than a change of the prescription of glasses? Specify:________								
125. Sudden weakness or heaviness of arms or legs? Specify:________								
126. Numbness in arms or legs?								
127. Swelling in arms or legs?								
128. Stiffness in joints or bones? Specify:________								
129. Pains in joints or bones? Specify:________								
130. Spasms of limbs?								
131. Spells of dizziness?								
132. Have you fainted or blacked out?								
133. Very strong heartbeats?								
134. Irregular (fast, slow or inconstant) heartbeats?								

Have you ever had any of the following symptoms?			How frequently does (or did) this occur? (days, months, or years)	How long do (or did) the symptoms last? (days, months, or years)	Did you consult a doctor?		Doctor's name & address	Year most recently experienced
	No	Yes			No	Yes		
135. Have you had pain, discomfort, or trouble in or around your heart?								
136. Itching of the skin?								
137. Any unusual discoloration or eruptions on the skin? Specify:________								
138. Any problems with your stomach or digestive system? Specify:________								
139. Swollen glands in your neck, armpits or groin?								
140. Have you lost 20 or more pounds in the last five years? (include dieting)								

The following section is to be filled out by the wives of male fishermen/or/by fisherwomen. If the wife is deceased, would the husband complete this section to the best of his knowledge.

---

141. How many natural children do you have? ________

How many step or adopted children do you have? ________

Please list all of the pregnancies and outcomes of which you were the father/mother in the sequence they occurred.

Preg. #	Complications in this pregnancy (describe)	Outcome				Infants sex		Date of Birth	Live Birth Weight	Hospital, clinic or place of birth	Doctor's name
		Miscarriage	Stillbirth	Live Birth	Other	M	F				
1.											
2.											
3.											
4.											
5.											
6.											

141a. Have any of your natural children died? (do not include stillbirths nor step or adopted children)

1) ○ No 2) ○ Yes (If Yes, please complete the following table.)

	Sex		Date of Birth	Date of Death	Cause of Death	City and State in which death was reported
	M	F				
1.						
2.						
3.						
4.						

142. Do you know of any mental or physical abnormalities at birth (birth defects) in yourself or your natural children.

1) ○ No 2) ○ Yes (If Yes, please complete the following table.)

↓

(go to question 143)

	Relationship to you			(Check appropriate boxes)		
	Self	Son	Daughter	Living	Dead	Nature of Birth Defect (describe)
1.						
2.						
3.						
4.						

143. Do you use a birth control method? 1) ○ No 2) ○ Yes (If Yes, answer questions 144 and 145)
(go to question 146)

144. What method of birth control have you used the most during your adult life?
1) ○ pill 2) ○ IUD 3) ○ diaphragm 4) ○ foam or jelly 5) ○ rhythm 6) ○ condom 7) ○ other (specify): ______

145. At what age did you begin using birth control methods? ______

146. At what age did you begin to menstruate? ______

146a. Have you stopped menstruating? 1) ○ No 2) ○ Yes
(If No, go to question 149)

147. At what age did you stop menstruating? ______

148. Did the cessation occur naturally or due to surgery?
1) ○ Naturally 2) ○ Surgery → What was the reason for the surgery? ______
Doctor's name and address? ______ ______
name address

149. What is (was) the average length of your menstrual cycle? ______days (From first day of bleeding to first day of next period)

150. On the average, how long is (was) your period? ______days

151. In the past five years, has your blood flow during menstruation 1) ○ increased? 2) ○ decreased? 3) ○ stayed the same?

152. Have (or did) you experience any abnormal spotting or bleeding between your menstrual cycles? 1) ○ No 2) ○ Yes (go to question 153)
(go to question 154)

153. If yes, did you consult a physician? 1) ○ No 2) ○ Yes Doctor's name & address ______ ______
name address

154. Have you used, or did you use, any medications prescribed by a doctor for menstrual irregularities?
1) ○ No 2) ○ Yes → Name of medication ______

Questions 1-140 have been answered by ______

Questions 141-153 have been answered by ______

Thank you for your cooperation in this health survey. Please sign the consent form and return the questionnaire in the enclosed self-addressed stamped envelope.

MINNESOTA
WISCONSIN
MICHIGAN
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEW YORK
WEST VIRGINIA
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
ONTARIO
Duluth
Minneapolis
St Paul
Milwaukee
Chicago
Springfield
Indianapolis
Detroit
Toledo
Cleveland
Columbus
Dayton
Cincinnati
Pittsburgh
Erie
Buffalo
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Ottawa
Montreal

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Proxy Questionnaire

FISHERMEN HEALTH SURVEY

Instructions: To aid in our understanding of Mr./Mrs.______________'s fishing habits and health, we ask that you complete the following questionnaire answering the questions as you believe he (she) would. Answer as many questions as possible from your knowledge of Mr./Mrs.______________. If you don't know how they would have answered a question, write "don't know". Start with question number two.

(TO BE COMPLETED BY OFFICE)

Proxy interview of Mr./Mrs.____________________________

This proxy interview is being completed by:______________________

What is the relationship of the person completing the interview to Mr./Mrs.______________________? ______________________ Relationship

1. Address of person completing interview? ______________________________ Street

   ______________________ City ______________ State ____________ Zip

---

2. What was his/her sex? 1) ☐ Male 2) ☐ Female
3. What was his/her race? 1) ☐ White 2) ☐ Black 3) ☐ Hispanic 4) ☐ American Indian 5) ☐ Other
4. What was his/her birthdate? ________ / ______ / ________ month day year
5. What was his/her Social Security number? _____ - _____ - _____
6. What was his/her marital status? 1) ☐ Single (never married) 2) ☐ Married 3) ☐ Separated or divorced 4) ☐ Widowed
7. Did he/she hold a current commercial fishing license? 1) ☐ No 2) ☐ Yes Approximately over what years did he/she hold a license? ____ / ____ from to (go to question 10)
8. Did he/she hold a commercial fishing license in the past? 1) ☐ No 2) ☐ Yes Approximately over what years did he/she hold a license? ____ / ____ from to (go to question 10)

9. Was he/she ever a crew member for, or a partner with, an individual owning a commercial fishing license?
1) ☐ No
2) ☐ Yes ⟶ Over what years was he/she a crew member or partner? ____/____
from to

(If no, please stop here and return the questionnaire as soon as possible in the addressed envelope. Thank you for your cooperation.)

10. Indicate with an "X" on the enclosed map where he/she commercially fished most often. (You may indicate more than one location).

11. Was commercial fishing his/her current full-time occupation? 1) ☐ No →

12. What was his/her current full-time occupation? ____________________

13. Was commercial fishing ever his/her full-time occupation?

2) ☐ Yes → Over what years was ne/she full time? ____/____ (from / to)

1) ☐ No → Over what years was he/she a part-time fisherman? ____/____ (from / to)
(go to question 14)

☐ Yes → Over what years did he/she commercially fish full time? ____/____ (from / to) (go to question 14)

14. Did he/she currently own a sport fishing license? 2) ☐ Yes 1) ☐ No

15. Did he/she ever own a sport fishing license? 2) ☐ Yes 1) ☐ No
(go to question 17)

16. Indicate with an "0" on the enclosed map where he/she sport fished most often. (You may indicate more than one location.)

17. To the best of your knowledge, please list the names and addresses of his/her full or part-time crew members? (past and present)

Name	Street	City	State	Zip	Employed From	To

18. Did he/she consume any of the fish they caught commercially or as a sport fisherman? 1) ☐ Yes 2) ☐ No (if no, go to question 28)

19. Approximately how many of his/her meals contained fish caught (by themselves or a friend) from the Great Lakes?
1) _____ per week (or) 2) _____ per month

20. How many of those meals include the following types of fish:

_______Salmon _______Walleye _______Rough fish _______Northern Pike _______Lake Trout _______Bass _______Pan fish

_______Other Trout _______Perch _______Burbot _______Chub _______Lake Whitefish _______Smelt _______Lake Herring

_______Other: (specify)______________________________

21. Approximately how many years did he/she consume Great Lakes fish with this frequency? _____years

22. Approximately how many of his/her meals contained fish caught (by themselves or a friend) from waters other than the Great Lakes?
1) _____per week (or) _____per month

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23. How many of those meals include the following types of fish:

_______Salmon _______Walleye _______Rough fish _______Northern Pike _______Lake Trout _______Bass _______Pan fish

_______Other Trout _______Perch _______Burbot _______Chub _______Lake Whitefish _______Smelt _______Lake Herring

_______Other: (specify)____________________________

24. Approximately how many years did he/she consume inland water fish with this frequency? _______years

25. How often did his family members eat fish?

Wife:	**Sons:**	**Daughters:**
1) ☐ As often as he/she	1) ☐ As often as he/she	1) ☐ As often as he/she
2) ☐ More often than he/she	2) ☐ More often than he/she	2) ☐ More often than he/she
3) ☐ Less often than he/she	3) ☐ Less often than he/she	3) ☐ Less often than he/she
4) ☐ Does not apply	4) ☐ Does not apply	4) ☐ Does not apply
5) ☐ Never	5) ☐ Never	5) ☐ Never

26. Approximately how many pounds of fish did he consume per year?

(assume: 1 fish meal equals ⅓ pound of fish) _______pounds

27. What percentages of fish he/she caught and consumed were prepared by the following methods:

1) Broiling ______%

2) Pan frying ______%

3) Smoked ______%

4) Boiling ______%

5) Poached ______%

6) Other ______%

28. Was he/she a cigarette smoker at the time of death? 1) ☐ No 2) ☐ Yes →

29. How old was he/she when he/she first began to smoke cigarettes? ______

30. What was the average number of cigarettes he/she smoked per day? ______

31. How many years did he/she smoke cigarettes with this frequency? ______

(go to question 34)

28a. Was he/she ever a cigarette smoker? 1) ☐ No 2) ☐ Yes →

(If No, go to question number 34)

32. How old was he/she when he/she first began to smoke cigarettes? ______

33. How many years did he/she smoke cigarettes? ______

(go to question 34)

34. Was he/she a pipe smoker at the time of death?

1) ☐ No 2) ☐ Yes →

35. How old was he/she when he/she first began to smoke a pipe? ________

36. What is the average number of pipefuls he/she smoked per day? ________

37. How many years did he/she smoke a pipe with this frequency? ________

(go to question 40)

34a. Was he/she ever a pipe smoker?

1) ☐ No 2) ☐ Yes →

(if No, go to question number 40)

38. How old was he/she when he/she first began to smoke a pipe? ________

39. How many years did he/she smoke a pipe? ________

(go to question 40)

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40. Was he/she a cigar smoker at the time of death? 1)☐ No 2)☐ Yes

41. How old was he/she when he/she began to smoke cigars? ____

42. What is the average number of cigard he/she smoked per day? ____

43. How many years did he/she smoke cigars with this frequency? ____

(go to question 46)

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40a. Was he/she ever a cigar smoker? 1)☐ No 2)☐ Yes

(If No, go to question number 46)

44. How old was he/she when he/she began to smoke cigars? ____

45. How many years did he/she smoke cigars? ____

(go to question 46)

46. Did he/she ever chew tobacco regularly? 1)☐ No 2)☐ Yes

47. Did he/she ever use snuff regularly? 1)☐ No 2)☐ Yes

48. Did he/she ever smoke non-tobacco products regularly? 1)☐ No 2)☐ Yes

Hard liquor is considered to include: Gin, Whiskey, Bourbon, Vodka, Rum, Brandy, or Scotch
(A drink=1 to 1½ oz. of alcohol or a mixed drink containing this amount.)

49. Was he/she a hard liquor drinker at the time of death? 1) ☐ No 2) ☐ Yes →

50. How old was he/she when he/she first began to drink hard liquor? ______

51. What is the average number of hard liquor drinks he/she consumed per week? ______

52. How many years did he/she consume hard liquor with this frequency? ______
(go to question 55)

49a. Was he/she ever a hard liquor consumer? 1) ☐ No 2) ☐ Yes →

(If No, go to question number 55)

53. How old was he/she when he/she first began to drink hard liquor? ______

54. How many years did he/she consume hard liquor drinks? ______
(go to question 55)

55. Was he/she a beer drinker at the time of death? 1) ☐ No 2) ☐ Yes →

56. How old was he/she when he/she first began to drink beer? ________

57. What is the average number of beers (12 oz. bottles) he/she consumed per week? ______

58. How many years did he/she consume beer with this frequency? ________

(go to question 61)

55a; Was he/she ever a beer drinker? 1) ☐ No 2) ☐ Yes →

(If No, go to question number 61)

59. How old was he/she when he/she first began to drink beer? ________

60. How many years did he/she consume beer? ________

(go to question 61)

61. Was he/she a wine drinker at the time of death? 1) ☐ No 2) ☐ Yes →

62. How old was he/she when he/she first began to drink wine? ________

63. What is the average number of wine drinks he/she consumed per week? ________

64. How many years did he/she consume wine with this frequency? ________ (go to question 67)

61a. Was he/she ever a wine drinker? 1) ☐ No 2) ☐ Yes →

(Go to question number 67.)

65. How old was he/she when he/she first began to drink wine? ________

66. How many years did he/she consume wine with this frequency? ________ (go to question 67)

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Did (he/she), his or her spouse, or any of his/her children ever have any of the following diseases or conditions. (Please check appropriate box).

67.	Asthma	1) ☐ No	2) ☐ Yes
68.	Bronchitis	1) ☐ No	2) ☐ Yes
69.	Emphysema	1) ☐ No	2) ☐ Yes
70.	Tuberculosis-TB	1) ☐ No	2) ☐ Yes
71.	Mononucleosis-Mono-Kissing Disease	1) ☐ No	2) ☐ Yes
72.	Pneumonia	1) ☐ No	2) ☐ Yes
73.	Any other disease of the respiratory system Specify:_______________	1) ☐ No	2) ☐ Yes
74.	Hepatiris or yellow jaundice	1) ☐ No	2) ☐ Yes
75.	Cirrhosis	1) ☐ No	2) ☐ Yes
76.	Any other liver disease Specify:_______________	1) ☐ No	2) ☐ Yes
77.	Spondylitis	1) ☐ No	2) ☐ Yes
78.	Gout	1) ☐ No	2) ☐ Yes
79.	Rheumatoid Arthritis	1) ☐ No	2) ☐ Yes
80.	Osteoarthritis	1) ☐ No	2) ☐ Yes
81.	Any other diseases of bones and joints Specify:_______________	1) ☐ No	2) ☐ Yes
82.	High triglycerides	1) ☐ No	2) ☐ Yes
83.	Meningitis	1) ☐ No	2) ☐ Yes
84.	Hypertension or high blood pressure	1) ☐ No	2) ☐ Yes
85.	High cholesterol	1) ☐ No	2) ☐ Yes
86.	Angina pectoris	1) ☐ No	2) ☐ Yes
87.	Heart attach-MI or coronary stroke-cerebral accident (CVA)	1) ☐ No	2) ☐ Yes
88.	Hemorrhage- thrombosis-embolism-any other disease of heart	1) ☐ No	2) ☐ Yes
89.	Or circulatory system Specify:_______________	1) ☐ No	2) ☐ Yes
90.	Diabetes	1) ☐ No	2) ☐ Yes
91.	Thyroiditis	1) ☐ No	2) ☐ Yes
92.	Any other glandular disorder Specify:_______________	1) ☐ No	2) ☐ Yes
93.	Eye diseases Specify:_______________	1) ☐ No	2) ☐ Yes
94.	Psoriasis	1) ☐ No	2) ☐ Yes
95.	Eczema	1) ☐ No	2) ☐ Yes
96.	Herpes zoster-shingles (dermatitis)	1) ☐ No	2) ☐ Yes
97.	Pemphingus	1) ☐ No	2) ☐ Yes
98.	Any other diseases of skin Specify:_______________	1) ☐ No	2) ☐ Yes
99.	Multiple Sclerosis	1) ☐ No	2) ☐ Yes
100.	Any other diseases of nervous system Specify:_______________	1) ☐ No	2) ☐ Yes
101.	Anemia	1) ☐ No	2) ☐ Yes
102.	Gastritis	1) ☐ No	2) ☐ Yes
103.	Ulcers(stomach or duodenal)	1) ☐ No	2) ☐ Yes
104.	Any other diseases of the digestive system Specify:_______________	1) ☐ No	2) ☐ Yes

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105.	Cancer of the breast	1) ☐ No	2) ☐ Yes
106.	Cancer of the stomach	1) ☐ No	2) ☐ Yes
107.	Cancer of the esophagus	1) ☐ No	2) ☐ Yes
108.	Cancer of the mouth or tongue	1) ☐ No	2) ☐ Yes
109.	Cancer of the large intestine	1) ☐ No	2) ☐ Yes
110.	Cancer of the rectum	1) ☐ No	2) ☐ Yes
111.	Cancer of the trachea, bronchus or lung	1) ☐ No	2) ☐ Yes
112.	Cancer of the liver or biliary passage	1) ☐ No	2) ☐ Yes
113.	Cancer of the bladder or urinary organs	1) ☐ No	2) ☐ Yes
114.	Cancer of the skin	1) ☐ No	2) ☐ Yes
115.	Cancer of the thyroid	1) ☐ No	2) ☐ Yes
116.	Leukemia	1) ☐ No	2) ☐ Yes
117.	Other Cancer Specify:______________	1) ☐ No	2) ☐ Yes

For *each* of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/condition ______________________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/condition ______________________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/condition ______________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/condition ______________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/
condition ________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/
condition ________

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

For each of the diseases you have checked on the preceeding two pages please complete the following tables:

Name of disease/
condition

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

Name of disease/
condition

Please list the name(s) of family member(s) with this disease/condition	Please list the name(s) and address(es) of the clinic(s), hospital(s) or doctor(s) consulted	Please give the date of diagnosis

118. How many children did he/she have? (_____ natural children) and (_____ step or adopted children)

Please list all the pregnancies and outcomes of which he/she was the father/mother in the sequence they occurred.

Pregnancy sequence number	Miscarriage	Stillbirth	Live Birth	Other	Infants Sex		Date of Birth	Live Birth Weight	Hospital, Clinic, or place of birth	Doctor's Name
					M	F				
1										
2										
3										
4										
5										
6										

119. Have any of his/her natural children died? (do not include stillbirths nor step or adopted children)

1) ☐ No 2) ☐ Yes (If yes, please complete the following table.)

	Sex		Date of Birth	Date of Death	Cause of Death	City and State in which death was reported
	M	F				
1.						
2.						
3.						
4.						

120. Do you know of any mental or physical abnormalities at birth (birth defects) in him/her or his/her natural children.

1) ☐ No 2) ☐ Yes (If yes, please complete the following table.)

↓ (go to question 121)

	Relationship to him/her (check appropriate boxes)					
	Himself/herself	Son	Daughter	Living or dead		Nature of Birth Defect (describe)
1.						
2.						
3.						
4.						

Did he/she ever have any of the following symptoms?	No	Yes	How frequently did this occur? (days, months, or years)	How long did the symptoms last? (days, months or years)	Did he/she consult a doctor? No	Yes	Doctor's name & address	Year most recently experienc
121. Severe fever								
122. Extreme tiredness								
123. Frequent or very bad headaches								
124. Problems with mouth or throat								
125. Any problems with ears or hearing SPECIFY: ______								
126. Any unusual difficulty with eyes or eyesight other than a change of the prescription of glasses? SPECIFY: ______								
127. Sudden weakness or heaviness of arms or legs? SPECIFY: ______								
128. Numbness in arms or legs?								
129. Swelling in arms or legs?								
130. Stiffness in joints or bones? SPECIFY: ______								
131. Pains in joints or bones? SPECIFY: ______								
132. Spasms of limbs?								
133. Did he/she have spells of dizziness?								
134. Did he/she faint or black out?								
135. Very strong heartbeats?								

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[illegible] ever have any of the following symptoms?	No	Yes	How frequently did this occur? (days, months, or years)	How long did the symptoms last? (days, months or years)	Did he/she consult a doctor? No	Yes	Doctor's name & address	Year most recently experienc
136. Irregular (fast, slow, or inconstant) heartbeats?								
137. Did he/she have pain, discomfort, or trouble in or around the heart?								
138. Itching of the skin?								
139. Any unusual discoloration or eruptions on the skin? SPECIFY:								
140. Any problems with the stomach or digestive system? SPECIFY:								
141. Swollen glands in the neck, armpits or groin?								
142. Did he/she lose 20 or more pounds in the last five years prior to death? (include dieting)								

The following section is to be filled out by the wife of male fishermen/or/by fisherwomen. If the wife is deceased, would you complete this section to the best of your knowledge about the practices of the fisherman's wife.

---

143. Do she use a birth control method? 1)☐ No 2)☐ Yes (If yes, answer questions 144 and 145)

144. What method of birth control do she use?
1.☐ pill 2.☐ IUD 3.☐ diaphragm 4.☐ foam or jelly 5☐ rhythm 6.☐ other Specify: ____________

145. At what age did she begin using birth control methods? ________.

146. At what age did she begin to menstruate? ________.

146a. Have you stopped menstruating? 1)☐ Yes 2)☐ No (go to question 149)
↓

147. At what age did she stop? ______

148. Did the cessation occur naturally or due to surgery?
1.☐ Naturally 2.☐ Surgery → What was the reason for the surgery? ____________
Doctor's name & address? ____________
name address

149 What is (was) the average length of her menstrual cucle? ______ days[1] (From the first day of bleeding to the first day of next period.)

150. On the average, how long is (was) her period? ________ (days)

151. In the past five years, had her blood flow during menstruation 1☐ increased? 2☐ decreased? 3☐ stayed the same?

152. Have (or did) she experience any abnormal spotting or bleeding between her menstrual cycles? 1☐ No (go to question 154) 2☐ Yes (go to question 153)

153. If yes, did she consult a physician? 1.☐ No 2.☐ Yes Doctor's name & address ____________
name address

154. Had she used, or did she use, any medications prescribed by a doctor for menstrual irregularities?
1.☐ No 2.☐ Yes Name of medication ____________

Questions 143-154 have been completed by ____________.
name

Thank you for your cooperation in this health survey. Please sign the consent form and return the questionnaire in the enclosed self-addressed stamped envelope.

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Respondent ID No. __/__/__/__/__

Date	Day of Week	Time	Result of Contact (Enter Code)	Comments	Interviewer ID No.

Results Codes

Interview complete 01
Refusal 02
Unavailable 03
Language problem 04
Deceased 05
Respondent moved 06
Incompetent 07
Apointment made 08
Call back, no appt. made . 09
No answer, no one home. . 10
Line busy 11

Telephone Interview
Large Cohort

GREAT LAKES FISHERMEN HEALTH SURVEY

Interviewer Name______________________________

Interviewer ID No______________________________

Respondent ID No __/__/__/__/__

Date of Outcome __/__/__

Interview Time Began__________a.m./p.m.

Interview Time Ended__________a.m./p.m.

University of Minnesota
Division of Epidemiology

GREAT LAKES FISHERMEN HEALTH SURVEY

I WOULD LIKE TO BEGIN BY ASKING SOME GENERAL QUESTIONS ABOUT YOURSELF.

1. First, what is your current address? ______________________________
street
______________________, ________ ________
city state zip

2. What is your birthdate? ________/_____/_____
month day year

3. What is your current marital status?
1. ○ Single (never married)
2. ○ Married
3. ○ Separated or divorced
4. ○ Widowed

4. How many children do you have? _____ Sons _____ Daughters

5. Do you presently hold a commercial fishing license?

1. ○ No 2. ○ Yes → Approximately how long have you held this license? ________ No. of years

(PROBE FOR DIFFERENT PERIODS OF TIME)

_____/_____ from to _____/_____ from to _____/_____ from to

GO TO QUESTION 8

6. Did you ever hold a commercial fishing license?

1. ○ No. 2. ○ Yes → Approximately how long did you hold this license? ________ No. of years

(PROBE FOR DIFFERENT PERIODS OF TIME)

_____/_____ from to _____/_____ from to _____/_____ from to

GO TO QUESTION 8

7. Have you ever been a crew member for, or a partner with, an individual owning a commercial fishing license?

1. ○ No 2. ○ Yes → How long have you been a crew member or partner? ________ No. of years

(PROBE FOR DIFFERENT PERIODS OF TIME)

_____/_____ from to _____/_____ from to _____/_____ from to

IF NO, STOP THE INTERVIEW. THANK THE RESPONDENT FOR HIS COOPERATION AND EXPLAIN THAT CURRENTLY WE ARE ONLY INTERVIEWING PEOPLE WHO HAVE COMMERCIALLY FISHED.

8. Near what towns do (did) you commercially fish most often?

city ______________, state ______ city ______________, state ______
______________, ______ ______________, ______
______________, ______ ______________, ______
______________, ______ ______________, ______

8a. Where is (was) your hailing port?

______________, ______
city state

300

9. Is commercial fishing your current full time occupation?

1. ○ No 2. ○ Yes → How long have you commercially fished full time? ______ No. of years

(PROBE FOR DIFFERENT PERIODS OF TIME)

______/______ from to ______/______ from to ______/______ from to

↓ GO TO QUESTION 12

10. What is your current full time occupation? (PROBE FOR TITLE, DUTIES AND PLACE OF EMPLOYMENT)

______________________ title/duties ______________________ place of employment

11. Was commercial fishing ever your full time occupation?

1. ○ No 2. ○ Yes ⟶ How long were you full time? (PROBE FOR DIFFERENT PERIODS OF TIME)

No. of years ____ ____/____ ____/____ ____/____

How long have you been a part time commercial fishermen? (PROBE FOR DIFFERENT PERIODS OF TIME)

No. of years ____ ____/____ from to ____/____ from to ____/____ from to

12. To the best of your knowledge, tell me the names and addresses of full or part time crew members. (Past and present).

		Employment	
name	street, city, state, zip, phone number	No. of years	from - to
			/
			/
			/
			/
			/
			/
			/
			/

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In this section I am going to ask you some questions about your fish consumption habits.

13. Approximately how many times do you eat fish from the Great Lakes?

1. _____ Never
2. _____ 1-2 times/week
3. _____ 3-5 times/week
4. _____ 6-7 times/week
5. _____ < 1 time/month
6. _____ 1 time/month
7. _____ 2-3 times/month

14. Approximately how many years have you consumed Great Lakes fish with this frequency? _____ No. of years

15. On the average, how many pounds of fish do you consume per meal? _____ Pounds of fish

16. What types of Great Lakes fish do you eat most often?

_____ Salmon
_____ Perch
_____ Walleye
_____ Burbot
_____ Rough Fish
_____ Chub
_____ Northern Pike
_____ Lake Whitefish
_____ Lake Trout
_____ Smelt
_____ Bass
_____ Lake Herring
_____ Pan Fish
_____ Other Trout
_____ Other (specify)
_____

17. In comparison to yourself, how often does your family eat fish?

Wife:

1. _____ As often as myself
2. _____ More often than myself _____ How often?
3. _____ Less often than myself _____ How often?
4. _____ Does not apply
5. _____ Never
6. _____ Don't know

_____________:

1. _____ As often as myself
2. _____ More often than myself _____ How often?
3. _____ Less often than myself _____ How often?
4. _____ Does not apply
5. _____ Never
6. _____ Don't know

_____________:

1. _____ As often as myself
2. _____ More often than myself _____ How often?
3. _____ Less often than myself _____ How often?
4. _____ Does not apply
5. _____ Never
6. _____ Don't know

_____________:

1. _____ As often as myself
2. _____ More often than myself _____ How often?
3. _____ Less often than myself _____ How often?
4. _____ Does not apply
5. _____ Never
6. _____ Don't know

_____________:

1. _____ As often as myself
2. _____ More often than myself _____ How often?
3. _____ Less often than myself _____ How often?
4. _____ Does not apply
5. _____ Never
6. _____ Don't know

_____________:

1. _____ As often as myself
2. _____ More often than myself _____ How often?
3. _____ Less often than myself _____ How often?
4. _____ Does not apply
5. _____ Never
6. _____ Don't know

In the next section, I would like to ask you some questions about your tobacco and alcohol use.

18. Do you smoke cigarettes now?

1. ○ No 2. ○ Yes →

19. How old were you when you first began to smoke cigarettes? ____

20. What is the average number of cigarettes you presently smoke per day? ____

21. How many years have you smoked with this frequency? ____

GO TO QUESTION 25

18a. Did you ever smoke cigarettes?

1. ○ No 2. ○ Yes →

22. How old were you when you first began to smoke cigarettes? ____

23. How many cigarettes did you smoke per day? ____

24. How many years did you smoke cigarettes? ____

GO TO QUESTION 25

GO TO QUESTION 25

25. Do you smoke a pipe now?

1. ○ No 2. ○ Yes →

26. How old were you when you first began to smoke a pipe? ____

27. What is the average number of pipefuls you presently smoke per day? ____

28. How many years have you smoked a pipe with this frequency? ____

GO TO QUESTION 32

↓

25a. Did you ever smoke a pipe?

1. ○ No 2. ○ Yes →

29. How old were you when you first began to smoke a pipe? ____

30. How many pipefuls did you smoke per day? ____

31. How many years did you smoke a pipe? ____

GO TO QUESTION 32

↓

32. Do you smoke cigars now?

1. ○ No 2. ○ Yes →

33. How old were you when you began to smoke cigars? ____

34. What is the average number of cigars you presently smoke per day? ____

35. How many years have you smoked cigars? ____

GO TO QUESTION 39

↓

32a. Did you ever smoke cigars?

1. ○ No 2. ○ Yes →

36. How old were you when you began to smoke cigars? ____

37. How many cigars did you smoke per day? ____

38. How many years did you smoke cigars? ____

GO TO QUESTION 39

↓

GO TO QUESTION 39

39. Have you ever chewed tobacco regularly?

1. ○ No 2. ○ Yes

40. Have you ever used snuff regularly?

1. ○ No 2. ○ Yes

HARD LIQUOR IS CONSIDERED TO INCLUDE: Gin, Whiskey, Scotch, Vodka, Rum, Brandy.
(One drink = 1 to 1½ ounces of alcohol)

41. Do you drink hard liquors now?

1. ○ No ↓ 2. ○ Yes →

42. How old were you when you first began to drink hard liquors? ____

43. What is the average number of hard liquor drinks you have per week? ____

44. How many years have you consumed hard liquor with this frequency? ____

GO TO QUESTION 48

41a. Did you ever drink hard liquors in the past?

1. ○ No ↓ 2. ○ Yes →

GO TO QUESTION 48

45. How old were you when you first began to drink hard liquor? ____

46. How many drinks did you have per week? ____

47. How many years did you drink hard liquor? ____

GO TO QUESTION 48

48. Do you drink beer now?

1. ○ No 2. ○ Yes →

49. How old were you when you first began to drink beer? ____

50. What is the average number of beers (12 oz. bottles) you presently drink per week? ____

51. How many years have consumed beer with this frequency? ____

GO TO QUESTION 55

48a. Did you ever drink beer?

1. ○ No 2. ○ Yes →

52. How old were you when you first began to drink beer? ____

53. How many beers did you drink per week? ____

54. How many years did you drink beer? ____

GO TO QUESTION 55

55. Do you drink wine now?

1. ○ No 2. ○ Yes →

56. How old were you when you first began to drink wine? ____

57. What is the average number of wine drinks (4-6 oz. glass) you have per week? ____

58. How many years have you consumed wine with this frequency? ____

GO TO QUESTION 62

GO TO QUESTION 55a

55a. Did you ever drink wine?

1. ○ No → GO TO QUESTION 62

2. ○ Yes →

59. How old were you when you first began to drink wine? ____

60. How many wine drinks did you have per week? ____

61. How many years did you drink wine? ____

GO TO QUESTION 62

In this section I would like to ask you some medical conditions you or your family may have had. Please tell me if you, your wife, or children have ever had any of the following conditions or diseases diagnosed by a doctor.

Disease	1-No 2-Yes 3-Don't Know	Family Member S-Self W-Wife Son D-Daughter	Name & Address of Clinics, Hospitals, or Doctors Consulted	Date of Diagnosis
62. Asthma				
63. Bronchitis				
64. Emphysema				
65. Tuberculosis-TB				

Disease	1-No 2-Yes 3-Don't Know	Family Member S-Self W-Wife Son D-Daughter	Name & Address of Clinics, Hospitals, or Doctors Consulted	Date of Diagnosis
66. Mononucleosis-Mono-Kissing Disease				
67. Pneumonia				
68. Any other disease of the respiratory system Specify: ____________				
69. Hepatitis or yellow jaundice				
70. Cirrhosis of the liver				
71. Any other liver disease Specify: ____________				
72. Spondylitis				
73. Gout				
74. Rheumatoid Arthritis				
75. Osteoarthritis				
76. Any other diseases of bones and joints Specify: ____________				
77. Meningitis				
78. Hypertension or high blood pressure				

Disease	1-No 2-Yes 3-Don't Know	Family Member S-Self W-Wife Son D-Daughter	Name & Address of Clinics, Hospitals, or Doctors Consulted	Date of Diagnosis
79. High cholesterol				
80. Angina pectoris				
81. Heart attack-MI or coronary				
82. Stroke, cerebral accident, (CVA)-hemorrhage, thrombosis, embolism				
83. Any other heart or circulatory disease Specify: ____________				
84. Diabetes				
85. Thyroiditis				
86. Any other glandular disorder Specify: ____________				
87. Eye disease Specify: ____________				
88. Psoriasis				
89. Eczema				
90. Herpes zoster-shingles (dermatitis)				
91. Pemphigus				

Disease	1-No 2-Yes 3-Don't Know	Family Member S-Self W-Wife Son D-Daughter	Name & Address of Clinics, Hospitals, or Doctors Consulted	Date of Diagnosis
92. Any other diseases of skin Specify: ________				
93. Multiple Sclerosis				
94. Any other diseases of the nervous system Specify: ________				
95. Anemia				
96. Gastritis				
97. Ulcers (stomach or duodenal)				
98. Any other diseases of the digestive system Specify: ________				
99. Have you, your wife, or children ever had cancer?				
99a. If yes, what location?				
100. Leukemia				
101. Hodgkin's Disease				
102. Other Cancer Specify: ________				
103. Mental retardation				
104. Any other disease Specify: ________ ________				

In this next section I am interested only in symptoms you may have experienced. Have you ever had any of the following symptoms?

	Symptom	1-No 2-Yes 3-Don't Know	How often does (did) this occur (PROBE for times per day, times per week, etc.)	How long did the symptoms last? (PROBE for hours, days, weeks, months or years.)	Did you consult a doctor? 1-No 2-Yes 3-Don't Know	Doctor's name and address	Year most recently experienced
105.	Severe fever						
106.	Extreme tiredness						
107.	Frequent or very bad headaches						
108.	Problems with mouth or throat						
109.	Any problems with ears or hearing Specify: ________						
110.	Any unusual difficulty with eyes or eyesight other than a change of the prescription of glasses Specify: ________						
111.	Sudden weakness or heaviness of arms or legs? Specify: ________						

3/3

Symptom	1-No 2-Yes 3-Don't Know	How often does (did) this occur (PROBE for times per day , times per week, etc.)	How long did the symptoms last? (PROBE for hours days, weeks, months or years)	Did you consult a doctor? 1-No 2-Yes 3-Don't Know	Doctor's name and address	Year most recently experienced
112. Numbness in arms or legs						
113. Swelling in arms or legs						
114. Stiffness in joints or bones? Specify:						
115. Pains in joints or bones? Specify:						
116. Spasms of limbs?						
117. Spells of dizziness						
118. Have you fainted or blacked out?						
119. Irregular, fast or slow heartbeats?						
120. Have you had pain discomfort, or trouble in or around your heart?						

3-3

	Symptom	1-No 2-Yes 3-Don't Know	How often does (did) this occur (PROBE for times per day , times per week, etc.)	How long did the symptoms last? (PROBE for hours days, weeks, months or years)	Did you consult a doctor? 1-No 2-Yes 3-Don't Know	Doctor's name and address	Year most recently experienced
121.	Itching of the skin?						
122.	Any unusual discoloration or eruptions on the skin? Specify: ______						
123.	Any problems with your stomach or digestive system? Specify: ______						
124.	Swollen glands in your neck, armpits or groin?						
125.	Have you lost 20 or more pounds in the last five years? (include dieting)		☒	☒			

126. Finally, what is your race? ___ 1. White ___ 2. Black ___ 3. American Indian ___ 4. Other:________

The last section of the questionnaire relates to your wife and children. If I could speak to your wife, she may be able to answer the few questions remaining. Thank you very much for your time and cooperation.

What is your first name? ______________

127. How many natural children do you have? ________

128. How many step or adopted children do you have? ________

129. Please tell me about all pregnancies and outcomes of which you were the mother/father in the sequence they occurred. I am interested in your current marriage only.

Preg. No.	Complications in this pregnancy (describe)	Outcome				Infants sex		Date of Birth	Live Birth Weight	Hospital, clinic or place of birth	Doctor's name
		Mis-carriage	Still-birth	Live Birth	Other	M	F				
1											
2											
3											
4											
5											
6											

129a. Have any of your natural children died? (do not include stillbirths nor step or adopted children)

1. ○ No 2. ○ Yes (If yes, please complete the following table)

↓

GO TO QUESTION 130

	Sex		Date of Birth	Date of Death	Name of Child	Cause of Death	City and State in which death was reported
	M	F					
1							
2							
3							
4							

130. Do you know of any mental or physical abnormalities at birth (birth defects) in yourself or your natural children?

1. ○ No 2. ○ Yes (If yes, please complete the following table)

↓

GO TO QUESTION 131

	CHECK APPROPRIATE BOXES					Nature of Birth Defect (describe)
	Relationship to you			Living	Dead	
	Self	Son	Daughter			
1						
2						
3						

131. Do you use a birth control method?

1. ○ No ↓ 2. ○ Yes ⟶ GO TO QUESTION 132

131a. Did you ever use a birth control method?

1. ○ No ↓ 2. ○ Yes

GO TO QUESTION 134

132. What method of birth control have you used the most during your adult life?

1. ○ pill
2. ○ IUD
3. ○ diaphragm
4. ○ foam or jelly
5. ○ rhythm
6. ○ condom
7. ○ other (specify) ____________________

133. At what age did you begin using birth control methods? ________

134. At what age did you begin to menstruate? ________

135. Have you stopped menstruating?

1. ○ No ↓ 2. ○ Yes

GO TO QUESTION 137

136. Did the cessation occur naturally or due to surgery?

1. ○ Naturally 2. ○ Surgery

↓

What was the reason for the surgery? ______________________________

Doctor's name and address ______________________________

137. Have you taken any medications (since that time) prescribed by a doctor?

1. ○ No 2. ○ Yes → What medications are these? ____________________

____

____

↓

138. What is (was) the average number of days between periods? __________ days

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139. On the average, how long is (was) your period? ________ days

140. In the past five years, has your blood flow during menstruation

____ increased?

____ decreased?

____ stayed the same.

____ does not apply.

141. Have (did) you experience (d) any abnormal spotting or bleeding between your menstrual cycles?

1. ○ No 2. ○ Yes

↓

GO TO QUESTION 143

142. Did you consult a physcian?

1. ○ No 2. ○ Yes ⟶ Doctor's name and address: ______________________________

____

143. Have you used or did you use any medications prescribed by a doctor for menstrual irregularities?

1. ○ No 2. ○ Yes ⟶ Name of medication ________________________

____

____

That was my last question. Thank you very much for your time and cooperation.

FILL IN IMMEDIATELY AFTER COMPLETING THE INTERVIEW:

1. Questions 1 - 126 have been answered by ______________________.

2. Questions 127 - 143 have been answered by ______________________.

3. The overall quality of the interview was:
   - ____ 1. Very good
   - ____ 2. Good
   - ____ 3. Fair
   - ____ 4. Poor

4. How reliable do you feel the respondents' answers were?
   - ____ 1. High quality
   - ____ 2. Questionable
   - ____ 3. Generally reliable
   - ____ 4. Unreliable

Interviewer's comments: ____

____

____

____

____

APPENDIX III

Pilot Study and Survey Materials
Great Lakes Study

Contents

1 Introductory letter Protocol I

2 Introductory letter Protocol I - Proxy

3 Introductory letter Protocol II

4 Introductory letter Protocol II - Proxy

5 Introductory letter Protocol III

6 Introductory letter Protocol III - Proxy

7 Great Lakes Study Consent Form

8 Great Lakes Study Consent Form Without Medical Records Request

9 Great Lakes Study Consent Form - Proxy

10 Great Lakes Study Consent Form Without Medical Records Request - Proxy

11 Second Request for Consent Form

12 Medical Records Request Letter - Doctors

13 Medical Records Request Letter - Clinics

14 Medical Records Request Letter - Hospitals

15 Second Request for Medical Records

16 Medical Records Abstract Form

17 Validation Form

18 Death Certificate Request Letter

19 Death Certificate Abstract Form

20 Study Participation Request Letter (appropriate for individuals with no phone or unlisted numbers)

21 Study Participation Return Postcard

22 Set of Questions (appropriate for Protocol II Participants

The following materials were developed for use in the Survey of the Large Cohort of Commercial Fishermen.

23 Respondent Information Sheet

24 Interviewer Assignment Record

25 Definitions (appropriate for questioning regarding health histories)

26 Survey Manual - Great Lakes Fishermen Health Study

27 Non-interview Report

UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

Dear Fisherman:

The sport and commercial fishing industries of the Great Lakes region are of significant economic importance to the Great Lakes states. The health and well-being of the members of the fishing industry are important to their families as well as to the economy of the Great Lakes Basin.

In 1978 our "Great Lakes Project" was initiated to evaluate the health of those individuals involved with sport or commercial fishing in the Great Lakes. It is our understanding that you have either served on a commercial fishing vessel or have possessed a commercial fishing license.

In several days an interviewer will contact you by phone to ask you questions regarding your fishing practices and health status. Your answers will be kept confidential. This is a medically-related survey and we uphold your right to privacy.

Enclosed with this letter you will find a medical consent form. The interviewer will explain its purpose and answer any questions you may have regarding this health survey.

Thank you for you cooperation. Should you have any questions please call the study office, collect (612) 376-8775.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

HEALTH SCIENCES

UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
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In 1978 the University of Minnesota initiated a "Great Lakes Study" to evaluate the health of those individuals involved with sport or commercial fishing in the Great Lakes. It is our understanding that Mr./Mrs. ______________ served on a commercial fishing vessel or held a commercial fishing license.

In several days an interviewer will contact you by phone to ask you questions about the fishing practices and prior health status of Mr./Mrs.______________. We will ask that you answer our questions as you believe Mr./Mrs.______________would. Your answers will be kept confidential. This is a medically-related survey and we uphold your and Mr./Mrs.______________'s right to privacy.

Thank you for your cooperation. Should you have any questions please call the study office, collect (612) 376-8775.

Sincerely yours,

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Enclosed with this letter is a set of questions regarding your fishing practices and health status. A medical consent form is also enclosed. In a couple of days an interviewer will contact you by phone and request your answers to this set of questions. Your answers will be kept confidential. This is a medically-related survey and we uphold your right to privacy.

Thank you for your cooperation. Should you have any questions please call the study office, collect (612) 376-8775.

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Enclosed with this letter is a set of questions regarding the fishing practices and prior health status of Mr./Mrs. ________________. In a couple of days an interviewer will contact you by phone to ask you how you believe Mr./Mrs.______________ would have answered these questions. Your answers will be kept confidential. This is a medically-related survey and we uphold your and Mr./Mrs.__________________'s right to privacy.

Thank you for your cooperation. Should you have any questions please call the study office, collect (612) 376-8775.

Sincerely yours,

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In 1978 our "Great Lakes Project" was initiated to evaluate the health of those individuals involved with sport or commercial fishing in the Great Lakes. It is our understanding that you have either served on a commercial fishing vessel or have possessed a commercial fishing license.

Enclosed with this letter is a questionnaire which asks questions about your fishing practices and health status. We would like you to fill out the questionnaire to the best of your ability. A section at the end of the questionnaire is important for your wife to complete. Your answers will be kept confidential. This is a medically-related survey and we uphold your right to privacy.

On the last page you will find a medical consent form. We ask you for your signature so as to permit us to ask your doctor(s) for the exact diagnosis of the conditions you have listed. If your wife fills out the last section of the questionnaire, we ask that she sign the medical consent form as well. Regardless of whether you or your wife sign, complete the questionnaire and mail it back in the prestamped self-addressed envelope provided.

Thank you for your cooperation. Should you have any questions please call the study office, collect (612) 376-8775.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

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LMS:kb
encl.

HEALTH SCIENCES

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In 1978 the University of Minnesota initiated a "Great Lakes Study" to evaluate the health of those individuals involved with sport or commercial fishing in the Great Lakes. It is our understanding that Mr./Mrs.________________served on a commercial fishing vessel or held a commercial fishing license.

Enclosed with this letter is a questionnaire which asks questions regarding the prior fishing practices and health status of Mr./Mrs.________________. We ask that you complete the questionnaire, as you think Mr./Mrs.________________would. Your answers will be kept confidential. This is a medically-related survey and we uphold your right to privacy.

Thank you for your cooperation. Should you have any questions please call the study office, collect (612) 376-8775.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

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Great Lakes Study
Consent form

Name: ______________________________

Current Street Address: ______________________________
Street

____
City State Zip

(   ) ____________
Phone

I (we) hereby give my (our) permission to be interviewed by the "Great Lakes Study" of the University of Minnesota. My (our) involvement in this study is voluntary. My (our) participation consists of an interview of my (our) fishing practices and/or health status.

I (we) permit the "Great Lakes Study" to contact medical sources listed in the interview for the purpose of reviewing my (our) medical records. I (we) understand that all information contained within the interview and the review of medical records will be kept confidential and used only for research purposes. I (we) further understand that my (our) names will not be associated with the results of this survey.

______________________________ ____________
Husband Date

______________________________ ____________
Wife Date

Great Lakes Study
Consent form

Name: ______________________________

Current Street Address: ______________________________
Street

____
City State Zip

(   ) ____________________
Phone

I (we) hereby give my (our) permission to be interviewed by the "Great Lakes Study" of the University of Minnesota. My (our) involvement in this study is voluntary. My (our) participation consisits of an interview of my (our) fishing practices and/or health status.

I (we) understand that all information contained within the interview will be kept confidential and used only for research purposes. I (we) further understand that my (our) names will not be associated with the results of this survey.

______________________________ ____________________
Husband Date

______________________________ ____________________
Wife Date

Great Lakes Study
Consent form

Name: ______________________________

Current Street Address: ______________________________
Street

____
City State Zip

(   ) ____________________
Phone

I hereby give my permission to be interviewed by the "Great Lakes Study" of the University of Minnesota. My involvement in this study is voluntary. My participation consists of an interview of the fishing practices and prior health status of Mr./Mrs.______________________. I understand that in answering questions about Mr./Mrs.__________________ I will report only that information which I know to be true and will not be asked to make judgements or opinions about the character of that individual. I reserve the right to refuse to answer any question regarding Mr./Mrs.____________________which I do not believe to be in their best interest.

I permit the "Great Lakes Study" to contact the medical sources listed in the interview for the purpose of reviewing Mr./Mrs.________________ medical records. I understand that all information contained within the interview and the review of medical records will be kept confidential and used only for research purposes. I further understand that our names will not be associated with the results of this survey.

______________________________ ____________________
Signature Date

____
Relationship to Subject

Please return this form in the attached addressed, stamped envelope.
Thank you.

Great Lakes Study
Draft: Proxy Consent Form / interview only

Name: ______________________________

Current Street Address: ______________________________
Street

____
City State Zip

( ) ______________
Phone

I hereby give my permission to be interviewed by the "Great Lakes Study" of the University of Minnesota. My involvement in this study is voluntary. My participation consists of an interview of the fishing practices and prior health status of Mr./Mrs. ______________. I understand that in answering questions about Mr./Mrs. ______________ I will report only that information which I know to be true and will not be asked to make judgements nor opinions about the character of that individual. I reserve the right to refuse to answer any question regarding Mr./Mrs.______________ which I do not believe to be in their best interest.

______________________________ ______________
Signature Date

____
Relationship to deceased

Please return this form in the attached addressed, stamped envelope. Thank you.

UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

Thank you for your participation in the health study of Great Lakes commercial fishermen conducted by the University of Minnesota. We appreciate your contribution to this research in the field of preventative medicine.

We are writing to request your signed consent form. (Please find enclosed an additional consent form copy if you have discarded the original.) We ask that you sign the consent form and return it in the addressed, stamped envelope. Please be assured that all information we receive will be kept in the strictest confidence. Your name will not be associated with the study results in any way.

Thank you for your cooperation.

Sincerely,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

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UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

REF:

The patient named above is participating in a health study of Great Lakes commercial fishermen conducted by the University of Minnesota. This patient has given us permission to contact you about his/her medical history. A copy of his/her authorization is enclosed.

In order to classify this patient appropriately, we need to verify patient conditions with the exact diagnoses. We would appreciate your assistance in completing the enclosed Medical Records Abstract form. If you would prefer to send copies of clinical summaries or medical records, please do so.

We greatly appreciate your time and effort in complying with our request. Should you have any questions, please call, collect (612) 376-8775.

Thank you for your cooperation.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

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UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

ATTN: Medical Records

REF:

Dear Madam/Sir:

The patient named above is participating in a health study of Great Lakes commercial fishermen conducted by the University of Minnesota. This patient has given us permission to contact you about his/her medical history. A copy of his/her authorization is enclosed.

In order to classify this patient properly, we need diagnostic information regarding past and present medical conditions and would appreciate your completing the enclosed medical records abstract form. If you would prefer to send us a summary or copy of these medical records, please do so.

We wish to thank you in advance for your time and effort in complying with our request. Should you have any questions please call the study office, collect (612) 376-8775.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

HEALTH SCIENCES

UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

ATTN: Medical Records

REF:

Dear Madam/Sir:

The individual named above has indicated that he/she was a patient in your hospital. This individual is participating in a health study of Great Lakes commercial fishermen conducted by the University of Minnesota and has given us permission to review his/her medical records. A copy of his/her consent form is enclosed.

In order to classify this individual appropriately, we need to verify the patient's hospitalizations and diagnoses at your institution. We would appreciate your assistance in completing the enclosed medical records abstract. If you prefer to send copies of clinical summaries or medical records, please do so.

We greatly appreciate your time and effort in complying with our request. Should you have any questions, please call the study office, collect (612)376-8775.

Thank you for your cooperation.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

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HEALTH SCIENCES

UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

REF:

Several weeks ago we requested some specific medical information regarding one of your patients. In the event that you did not receive that communication, or misplaced the original copy, we enclose an additional form for your convenience.

The patient named above is participating in a health study of Great Lakes commercial fishermen conducted by the University of Minnesota and has given us permission to contact you regarding his/her medical history. A copy of his/her authorization is enclosed.

In order to classify this patient appropriately, we need to verify patient responses with exact medical records. We would appreciate your assistance by filling out the attached form. If you would prefer to send clinical summaries or copies of records, please do so.

We appreciate your time and effort in complying with our request. If you have already returned the form, please disregard this letter. Should you have any questions, do not hesitate to call the study office, collect (612) 376-8775.

Thank you for your cooperation.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

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Great Lakes Study

Medical Records Abstract

Dr./Mr./Mrs. ______________________________ has authorized the University of Minnesota, Department of Epidemiology, to review their medical records. A copy of the signed consent form is attached. We ask for your cooperation in varifying diagnoses made by yourself or your staff in the study participant.

(Obstetricians and Gynecologists please skip the first two questions and answer questions three, four and five). Thank you for your cooperation.

1. If you or any staff members have confirmed or diagnosed any of the following conditions, please check the corresponding box and write the exact date of diagnosis.

Disease Name	Condition has been confirmed or diagnosed in subject (✓)	Date of diagnosis
Asthma		
Bronchitis		
Emphysema		
Tuberculosis -TB		
Mononucleosis - Mono		
Pneumonia		
Any other respiratory disease SPECIFY: ____________		
Hepatitis or yellow jaundice		
Cirrhosis		
Any other liver disease SPECIFY: ____________		
Spondylitis		
Gout		
Rheumatoid arthritis		
Osteoarthritis		
Any other diseases of bones and joints SPECIFY: ____________		
High Triglycerides		
Meningitis		
Hypertension		

Disease Name	Condition has been confirmed or diagnosed in subject (✓)	Date of Diagnosis
High Cholesterol		
Angina pectoris		
Heart attack or MI		
Stroke- cerebral accident or CVA- hemorrhage, thrombosis, emoblism		
Any other heart or circulatory diseases SPECIFY:__________		
Diabetes		
Thyroiditis		
Any other glandular disorders SPECIFY:__________		
Eye diseases SPECIFY:__________		
Multiple Sclerosis-MS		
Any other disease of the nervous system SPECIFY:__________		
Anemia		
Gastritis		
Ulcers (stomach or duodenal)		
Any other disease of the digestive system SPECIFIC:__________		
Psoriasis		
Eczema		
Herpes Zoster (dermatitis) Shingles		
Pemphigus		
Any other skin disease SPECIFY:__________		
Cancers: Breast		
Stomach		
Esophagus		
Mouth or Tongue		
Large intestine		
Rectum		
Trachea, Bronchus or Lung		

Disease Name	Condition has been confirmed or diagnosed in subject (✓)	Date of Diagnosis
Cancers: Liver or Biliary passage		
Bladder and Urinary organs		
Skin		
Thyroid		
Leukemia		
Other:________________		
Mental Retardation		

2. If you or any staff members have been consulted regarding any of the following symptoms, please check the corresponding box and write in the exact date(s) of consultation.

Condition	Condition has been confirmed in subject	Date of Diagnosis
Severe fever		
Extreme tiredness		
Frequent or very bad headaches		
Problems with mouth or throat		
Any problems with ears or hearing SPECIFY:________________________		
Any unusual difficulty with eyes or eyesight other than a change of the prescription of glasses SPECIFY:________________________		
Sudden weakness or heaviness of arms or legs SPECIFY:________________________		
Numbness in arms or legs		
Swelling in arms or legs		
Stiffness in joints or bones SPECIFY:________________________		
Pains in joints or bones SPECIFY:________________________		
Spasms of limbs		
Spells of dizziness		
Fainted or blacked out		
Very strong heartbeats		
Irregular (fast, slow, or inconstant) heartbeats		
Pain, discomfort, or trouble in or around your heart		
Itching of the skin		

Condition	Condition has been confirmed in subject	Date of Diagnosis
Any unusual discoloration or erruptions on the skin SPECIFY: ______		
Any problems with your stomach or digestive system SPECIFY: ______		
Swollen glands in neck, armpits or groin		

3. Please list all the pregnancies and outcomes which you or your staff members provided medical care and assistance.

Pregnancy Number	Pregnancy Outcome				Infants Sex		Date of Birth	Live Birth Weight
	Abortion	Miscarriage	Stillbirth	Live Birth	M	F		
1								
2								
3								
4								
5								
6								

4. Has the subject ever consulted you or your staff members regarding abnormal spotting or bleeding between her menstrual cycles?

○ No ○ Yes Diagnosis: ______

Date: ______

5. Has the subject ever had surgery on her reproductive organs performed by you or your staff members?

○ No ○ Yes Diagnosis: ______

Date: ______

Type of surgery: ______

Date of surgery: ______

6. Has the subject experienced complications in any of the above listed pregnancies?

○ No ○ Yes Diagnosis: ______

Date: ______

Type of treatment: ______

Etiology: ______

CONSENT FORM INFORMATION REGARDING PARTICIPANT:

CURRENT ADDRESS: ____________________

____

PHONE (H): ____________________

(O): ____________________

INTERVIEWER: ____________________

NEVER REC'D: __________ OTHER: __________

UPDATE: ____________________

	DATE LETTERS SENT TO MEDICAL SOURCES:			RETURNS FROM MEDICAL SOURCES:			
	1st Mailing	2nd mailing & phone call	Comments from Phone call:	Abstract Forms	No Records	Chart Copy	Other
(1) CONTACT (Physician, Clinic or Hospital): ____________________ ____________________ ____________________ ____________________ DATE & REASON FOR CONTACT REGARDING: Mr/Mrs ____________________ ____________________ OTHER INFORMATION: ____________________							
(1) CONTACT (Physician, Clinic or Hospital): ____________________ ____________________ ____________________ ____________________ DATE & REASON FOR CONTACT REGARDING: Mr/Mrs ____________________ ____________________ OTHER INFORMATION: ____________________							

UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

Dear Sir:

The Departments of Environmental Health and Epidemiology, University of Minnesota, are currently involved in a study to evaluate the health status of commercial fishermen in the Great Lakes Basin. The validation procedure of this study involves the collection of medical records for living cohort members and the collection of death certificates for deceased cohort members.

We would appreciate receiving one copy of the death certificate of the person(s) listed on the attached sheet. We are listing the full name, social security number, date of birth, and date of death to assist in matching. In addition, we have developed a coding system for the results of your search (see attached sheet). Please return the roster with the death certificate and your notations.

Enclosed you will find a check for the retrieval costs of the death certificate search. Thank you for your cooperation.

Sincerely yours,

Leonard M. Schuman, M.D.
Professor and Director

LMS:kb
encl.

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UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

Commercial Fishermen Death Certificates

No.	Name	Death Date	Birth Date	Social Security Number	Results

*Code
+ = found
- = not found
I = further search needed
C = comment (add in space below name)

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UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S.E.
Minneapolis, Minnesota 55455

The Division of Epidemiology of the University of Minnesota is conducting a study to determine the general health patterns of families involved in the commercial fishing industry.

We have tried to contact you by phone to ask a few simple questions about you and your family's health. Since we have been unable to reach you, we ask that you please call us collect at: (612) 376-8775. Or, please write on the enclosed card a phone number where we can reach you.

Your contribution is important to the success of this project. We are willing to talk with you at a time that is convenient for you. All information that you share with us will be confidential. Your name will not be associated with the study results.

We would be glad to answer any questions that you may have regarding this study.

Thank you for your cooperation.

Sincerely,

Leonard M. Schuman, M.D.
Professor and Director

NAME: ______________________________

My phone number is (   ) ______________.

- I prefer not to release my phone number, but I will call the study office, collect (612) 376-8775 on ________________ (date) at __________ (time).

Thank you for your cooperation in this study.

We have provided the following list of questions for your review prior to the interviewer's call. We suggest that as you read through this list you note all necessary names, dates, and addresses requested. We hope that in providing you with an advanced listing of the interview questions, you will have time to consider your answers and gather information needed. Thank you for your cooperation.

What is your current address?

What is your sex?

What is your race?

What is your birthdate?

What is your Social Security number?

What is your marital status?

Do you presently hold a commercial fishing license?

Did you hold a commercial fishing license in the past?

- Approximately over what years have you held a license?
- Have you ever been a crew member for, or a partner with, an individual owning a commercial fishing license?
- Over what years have you been a crew member or partner?

Is commercial fishing your current full-time occupation?

- Over what years have you commercially fished full-time?

Do you currently own a sport fishing license?

To the best of your knowledge, please tell me the names and addresses of full or part-time crew members? (past and present)

Do (or did) you consume any of the fish you catch commercially or as a sport fisherman?

Approximately how many of your meals contain fish caught (by yourself or a friend) from the Great Lakes?

Approximately how many years have you consumed Great Lakes fish with this frequency?

Approximately how many of your meals contain fish caught (by yourself or a friend) from waters other than the Great Lakes?

How often do your family members eat fish?

Approximately how many pounds of fish have you consumed per year?

- (assume: 1 fish meal equals ½ pound of fish)
- What cooking methods are used in preparing the fish you consume?

Do you presently smoke cigarettes?

- How old were you when you first began to smoke cigarettes?
- What is the average number of cigarettes you presently smoke per day?
- How many years have you smoked cigarettes with this frequency?

- Did you smoke cigarettes in the past?
  - How old were you when you first began to smoke cigarettes?
  - How many years did you smoke cigarettes?
- Do you presently smoke a pipe?
  - How old were you when you first began to smoke a pipe?
  - What is the average number of pipefuls you presently smoke per day?
  - How many years have you smoked a pipe with this frequency?
- Did you smoke a pipe in the past?
  - How old were you when you first began to smoke a pipe?
  - How many years did you smoke a pipe?
- Do you presently smoke cigars?
  - How old were you when you began to smoke cigars?
  - What is the average number of cigars you presently smoke per day?
  - How many years have you smoked cigars with this frequency?
- Did you smoke cigars in the past?
  - How old were you when you began to smoke cigars?
  - How many years did you smoke cigars?
- Do you drink hard liquors?
  - How old were you when you first began to drink hard liquor?
  - What is the average number of hard liquor drinks you presently consume per week?
  - How many years have you consumed hard liquor with this frequency?
- Did you consume hard liquor in the past?
  - How old were you when you first began to drink hard liquor?
  - How many years did you consume hard liquor drinks?
- Do you drink beer?
  - How old were you when you first began to drink beer?
  - What is the average number of beers (12 oz. bottles) you presently consume per week?
  - How many years have you consumed beer with this frequency?
- Did you drink beer in the past?
  - How old were you when you first began to drink beer?
  - How many years did you consume beer?
- Do you drink wine?
  - How old were you when you first began to drink wine?
  - What is the average number of wine drinks you have per week?
  - How many years have you consumed wine with this frequency?
- Did you drink wine in the past?
  - How old were you when you frist began to drink wine?
  - How many years did you consume wine?

Have you, your wife, or any of your children ever had any of the following diseases or conditions.

Asthma
Bronchitis
Emphysema
Tuberculosis-TB
Mononucleosis-Mono-Kissing Desease
Pneumonia
Any other disease of respiratory system
Specify: ____________
Hepatitis or yellow jaundice
Cirrhosis
Any other liver disease
Specify: ____________
Spondylitis
Gout
Rheumatoid Arthritis
Osteoarthritis
Any other diseases of bones or joints
Specify: ____________
High triglycerides
Meningitis
Hypertension or high blood pressure
High cholesterol
Angina pectoris
Heart attack·MI or coronary
Stroke-cerebral accident-(CVA)
Any other diseases of the heart or circulatory system in the family
Specify: ____________
Diabetes
Thyroiditis
Any other glandular disorder
Specify: ____________

Eye diseases
Specify: ____________
Psoriasis
Eczema
Herpes zoster-shingles (dermatitis)
Pemphigus
Any other diseases of skin
Specify: ____________
Anemia
Gastritis
Ulcers (stomach or duodenal)
Any other diseases of the digestive system
Specify: ____________
Cancer of the breast
Cancer of the stomach
Cancer of the esophagus
Cancer of the mouth or tongue
Cancer of the large intestine
Cancer of the rectum
Cancer of the trachea, bronchus, lung
Cancer of the liver or biliary passag
Cancer of the bladder or urinary organs
Cancer of the skin
Cancer of the thyroid
leukemia
Other cancer
Specify: ____________
Mental Retardation

For each disease listed above you will be asked to list the names of family members who have had the disease, the consulting doctor or clinic, and the date of diagnosis.

How many natural and step or adopted children do you have?

Please list all pregnancies and outcomes of which you were the father/mother in the sequence they occurred. For each pregnancy we will ask:

Were there complications?

Was the outcome a miscarriage, stillbirth, live birth, or other?

What was the child's sex?

What was the date of birth?

What was the live birth weight?

Name the hospital, clinic, or place of birth.

What was the doctors name?

Have any of your natural children died? If yes, what was the child's sex, date of birth, date of death, cause of death, and the city and state in which the death was reported?

Do you know of any mental or physical abnormalities at birth (birth defects) in yourself or your natural children. If yes, who had the defect, are they living or dead, and what type of defect did they have?

Have you ever had any of the following symptoms?

Severe fever
Extreme tiredness
Frequent or very bad headaches
Problems with mouth or throat
Any prodlems with ears or hearing
  Specify:
Any unusual difficulty with eyes or eyesight other than a change of the prescription of glasses?
  Specify:
Sudden weakness or heaviness of arms or legs?
  Specify:
Numbness in arms or legs?
Swelling in arms or legs?
Stiffness in joints or bones?
  Specify:
Pains in joints or bones?
  Specify:
Spasms of limbs?

Have you had spells of dizziness?
Have you fainted or blacked out?
Very strong heartbeats?
Irregular (fast, slow, or inconstant) heartbeats?
Have you had pain, discomfort, or trouble in or around your heart?
Itching of the skin?
Any unusual discoloration or eruptions on the skin?
  Specify:
Any problems with your stomach or digestive system?
  Specify:
Swollen glands in your neck, armpits or groin?
Have you lost 20 or more pounds in the last five years? (include dieting)

If you have experienced any of the above symptoms you will be asked how frequently they occured, how long the symptoms lasted, the year you most recently experienced the symptoms, and the names of the doctors you consulted if applicable.

Fisherwomen or the wives of male fishermen will be asked the following questions. If the wife is deceased we will ask that the husband answer these questions to the best of his knowledge.

Do you use a birth control method?

What method of birth control do you use?

At what age did you begin using birth control methods?

At what age did you begin to menstruate?

Have you stopped menstruating?

At what age did you stop?

Did the cessation occur naturally or due to surgery? If due to surgery, what was the reason for the surgery and what was the doctor's name?

What is (was) the average length of your menstrual cycle? (From first day of bleeding to first day of next period)

On the average, how long is (was) your period?

In the past five years, has your blood flow during menstruation increased, decreased, or stayed the same?

Have (or did) you experience any abnormal spotting or bleeding between your menstrual cycles? If yes, you will be asked to give the name of the doctor you consulted if applicable.

Have you used, or did you use, any medications prescribed by a doctor for menstrual irregularities? If yes, what was the name of the medication.

GREAT LAKES FISHERMEN HEALTH STUDY

Respondent Information Sheet

Respondent ID Number: __/__/__/__/__

Name: ____________ ____________ ____________
last first middle

Address: ______________________________________
street

____________________, __________, __________
city state zip

Telephone: ______ __________
area code number

GREAT LAKES FISHERMEN HEALTH STUDY

INTERVIEWER ASSIGNMENT RECORD

Interviewer Name: ______________________________

Interviewer ID#: ____________

Assignments		Interviews		Comments
Respondent ID#	Date Assigned	Date of Interview	Date of Return	Refusal, Unavailable, etc.

DEFINITIONS

62.	Asthma	A condition marked by recurrent attacks of breathing difficulties marked by wheezing
63.	Bronchitis	Inflammation and usually infection of the bronchi, which is a part of the lung
64.	Emphysema	A lung disease characterized by destruction of lung tissue causing difficulty in breathing, often secondary to smoking
65.	Tuberculosis--TB	A specific infectious disease usually affecting the lung
66.	Mononucleosis-Mono-Kissing Disease	A virus disease characterized by severe changes in the white blood cells causing fatigue, severe sore throat, and swollen lymph glands
67.	Pneumonia	Infection of the lungs
69.	Hepatitis or yellow jaundice	Inflammation of the liver, frequently infectious
70.	Cirrhosis of the liver	A chronic disease of the liver characterized by the replacement of normal tissue by scar tissue
72.	Spondylitis	Inflammation of the spine
73.	Gout	A genetic form of arthritis which affects chiefly men and is due to high levels of uric acid in the blood
74.	Rheumatoid Arthritis	A persistent disease of the joints characterized by deformity and pain in the joints
75.	Osteoarthritis	A degenerative joint disease associated with wear and tear of the tissues and with aging
77.	Meningitis	Inflammation of the membrane around the brain and spinal cord usually caused by infection
78.	Hypertension or high blood pressure	Persistently high blood pressure
79.	High cholesterol	A high level of cholesterol in the blood
80.	Angina pectoris	Sudden tightness and pain in the chest occuring during physical exertion or tension, and subsiding with rest, caused by disease in the coronary arteries
81.	Heart attack-MI or coronary	Death of any muscle tissue of the heart

82.	Stroke, cerebral accident, (CVA)-hemorrhage, thrombosis, embolism	Death of brain tissue which results from lack of blood to a portion of the brain or from a hemorrhage in the brain
84.	Diabetes	A disease which is characterized by high levels of sugar in the blood
85.	Thyroiditis	Inflammation of the thyroid gland
88.	Psoriasis	A chronic disease of the skin which usually involves the scalp, elbows, knees, and shins
89.	Eczema	An inflammation, generally of the skin
90.	Herpes zoster-shingles (dermatitis)	An inflammatory disease of nerves caused by the virus of chicken pox and characterized by groups of small blisters in the skin
91.	Pemphigus	A disease characterized by clusters of large skin blisters
93.	Multiple Sclerosis	A disease of the central nervous system. Some symptoms are lack of coordination, weakness, speech and visual problems
95.	Anemia	A condition in which there are low levels of red blood cells in the body
96.	Gastritis	Persistent inflammation of the stomach
97.	Ulcers (stomach or duodenal)	A local cavity in the inside surface of the stomach or duodenum which usually results from inflammation in that area
100.	Leukemia	A chronic disease characterized by an abnormal increase in the number of leukocytes in the tissues and often in the blood
101.	Hodgkin's Disease	A disease marked by chronic enlargement of the lymph nodes, often cervical at the onset and then generalized, together with enlargement of the spleen and often of the liver

GREAT LAKES FISHERMEN HEALTH SURVEY

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INTRODUCTION TO SURVEYS

What is a Survey?

A survey usually involves collecting data from a group of people selected to accurately represent the population under study. This group of people is called a sample. People in the sample are asked a series of questions through the use of a questionnaire. The answers obtained are put together in an organized manner so that conclusions can be drawn. This information is then used in planning, research, and solving particular problems.

Skillful interviewing procedures are used to ensure full and accurate information. Careful methods are followed so that the data gathered from the sample or respondents can be confidently used to represent the total population. The use of the sample means that a small number of respondents can be selected to represent the whole population, making it possible to avoid the expensive and time consuming procedure of taking a census (a census involves a complete accounting of every person in the population being studied).

Interviewing

The interviewing stage, which is one of the core operations of any survey, includes the recruitment and training of interviewers, the preparation of general and specific interviewing instructions,field supervision, administration of interviews, and the validation of interviews.

During the interviewing period, the success of the survey rests solely in the hands of the interviewer. Researchers strive to develop the best interview guides possible, but even the best interview guide is only as good as the interviewer's skill in using it.

Ethics of Survey Interviewing

Persons working in jobs and professions which deal with the experiences, thoughts, actions and feelings of people have an ethical responsibility to these people. Survey research interviewing is one of these occupations, and interviewers must, therefore, accept the ethics of the profession. Just as doctors and lawyers must respect information about their patients and clients as privileged, so must the survey interviewer.

The interviewer must often ask questions that one would not think of asking a close friend; questions which might be thought of as "too personal." You will find that the average person is willing to answer these questions, sometimes offering information which would not be given even to a close friend or relative. Your protection of all information about respondents gained during the conduct of research is therefore essential.

The main reason research studies can point to success is confidentiality. Interviewers can, and do, promise the people who are interviewed that their answers to the questions will be kept strictly confidential.

USING THE QUESTIONNAIRE

Asking the Questions

The interviewer's goal is to collect accurate information through the use of the study questionnaire. Data from study participants must be collected in a uniform manner. Thus, all people in a sample must be asked the same questions in the same way.

The following principles and techniques must be employed when using the questionnaire:

1. Always remain neutral. The interviewer must be careful that nothing in words or manner implies criticism, surprise, approval, or disapproval of either the questions asked or the respondent's answers. Through a relaxed professional attitude, the interviewer can put the respondent at ease and gain his confidence. We need the respondent's answers to the questions with as little influence as possible by the interviewer. Another interviewer should be able to obtain the same answers.
2. Ask ALL questions in the order presented in the questionnaire. Never change the order of the questions in the questionnaire. The questions follow one another in a logical sequence; to change that sequence would subvert the intent of the questionnaire.

3. Ask ALL questions exactly as worded. Do not change even one word in the question that is printed for you. Many times, the smallest change can affect the whole meaning of the question. Simply repeat the question if the need arises. If you do repeat the question, read all the words in the question. Even though you feel that a question could be worded much more simply, do not improvise on the method of asking the question. Every word is there for a purpose. In order for all the interviewer's work to be combined there must be no doubt that each respondent heard exactly the same question before answering.

Maintaining Rapport

You began your rapport-building process with your introduction and it must be continued throughout the interview. Through your accepting and understanding behavior and your interest in the respondent, you can create a friendly atmosphere in which the respondent can talk freely and fully.

Occasionally, however, rapport may be broken during the interview because the respondent finds a particular question "too personal" for example. If the respondent feels a question is too personal, take time to reassure him that he may speak freely without fear. This may be done by restating the confidential nature of the questionnaire and the anonymous nature of the study. If a respondent refuses to answer a question after you have reassured him of confidentiality, do not press him. Record what the respondent said in refusing to answer the question and proceed to the next question. The interviewer should not irritate the respondent and provoke a refusal to complete the interview.

Probing

Probing is the technique used by the interviewer to stimulate discussion and obtain more information. A question has been asked and an answer is given. For any number of reasons, the answer may be inadequate, requiring the interviewer to seek more information. Probing, therefore, has three major functions: (1) to motivate the respondent to enlarge, clarify, or explain his answers; (2) to focus the respondent's answers so that irrelevant and unnecessary information can be eliminated; and (3) to pinpoint objective information, such as dates and names, as accurately as possible. This must be done, however, without introducing bias or antagonizing the respondent.

You must fully understand the purpose and meaning of each question. Once you understand the purpose of a question, you will find it much easier to decide if you have a satisfactory answer or whether you should probe for a clearer and more complete one.

Probes must alway remain neutral. Remember, probing is to motivate the respondent to respond more fully or to focus his answer without introducing bias. The potential for bias is great in the use of probes. Under the pressure of the interviewing situation, the interviewer may quite unintentionally imply that some answers are more acceptable than others or may hint that a respondent might want to consider this or include that in giving a response.

Kinds of Probes

A number of different neutral probes which appear as part of a normal conversation can be used to stimulate a fuller, complete response.

1. An expression of interest and understanding. By comments such as "uh-huh" or "I see" or "yes", the interviewer indicates that the response has been heard, that it is interesting, and that more is expected.
2. An expectant pause. The simplest way to convey to the respondent that you know he has begun to answer the question, but has more to say, is to be silent. The pause---often accompanied by an expectant look or nod of the head---allows the respondent time to gather his thoughts.
3. Repeat the question. When the respondent does not seem to understand the question, misinterprets it, seems unable to decide, or strays from the subject, it is often useful to repeat the question. Many respondents, when hearing the question a second time, realize what kind of answer is needed.
4. Repeating the respondent's reply. Simply repeating what the respondent has said is often an excellent probe. Hearing the response just given often stimulates the respondent to further thought.
5. A neutral question or comment. Neutral questions or com-

ments are often used to obtain clearer and fuller responses. Following are some suggestions for probing techniques.

Probes to Clarify

What do you mean exactly?
What do you mean by......?
Could you please explain that a little?
I don't think I quite understand.

Probes for specificity

What in particular do you have in mind?
Could you be more specific about that?
Tell me about that. What/who/how/why/when....?

Probes for data specificity

Was that before or after your first hospitalization?
Were you married during that time?
Who were you working for at the time?

Probes for relevance

I see. Well, let me ask you again..REPEAT EXACT QUESTION.
Would you tell me exactly how you mean that?

Probes for completeness

What else?

What else can you think of?

What other reason/things/examples, ect. can you think of?

The Don't Know Response

The "I don't know" answer can mean a number of things. For instance:

1. The respondent doesn't understand the question and says I don't know to avoid saying he doesn't understand.
2. The respondent is thinking the question over, and says I don't know to fill the silence and give himself time to think.
3. The respondent may be trying to evade the issue because he feels uninformed, or is afraid of giving the wrong answer, or because the question seems too personal.
4. The respondent may really not know the answer to a question.

If the respondent actually doesn't have the information requested of him, this in itself is significant to the study results. It is the interviewer's responsibility, however, to make certain this is the case. An expectant pause, a reassuring remark, repeating the question, a neutral question--all will encourage the respondent to reply.

Examples of Probing

The following are illustrations of probing which will help you avoid biasing the respondent's answer:

1. Don't ask whether a person means "this or that." This suggests only one of two answers, even though there may be many other possibilities which the respondent is thinking about.

   QUESTION: At the present time, what is the average number of cigarettes you smoke per day?
   RESPONSE: Oh, just a few.
   IMPROPER PROBE: Would that be three or four?
   (You are pushing the respondent to one of two alternatives when he might mean something else entirely)
   PROPER PROBE: And how many cigarettes is that?

2. Don't ask whether the respondent meant a particular thing by a certain word. This suggests one answer, when he might actually have another one in mind.

   QUESTION: What is your occupation at the present time?
   RESPONSE: I assist the manager.

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IMPROPER PROBE: Oh, you're a supervisor?

(The incorrect probe is an attempt to define for the respondent. A neutral probe will give the respondent an opportunity to tell what is meant.)

PROPER PROBE: Assisting the manager? Could you tell me a little bit more about that?

QUESTION BY QUESTION SPECIFICATIONS

Throughout the questionnaire, there are interviewer instructions and parts of some questions which are not meant to be read to the respondent (R). Those instructions and responses which should not be read are CAPITALIZED. The numbered responses in most questions should not be read to the R. Follow the interviewer's instructions carefully and record all responses clearly and legibly.

During an interview, a R may answer "I don't know," or he may refuse to answer a question. In this case, these responses should be recorded as "don't know" or "refuse to answer" respectively.

QUESTION BY QUESTION SPECIFICATIONS

Q1 Verify address with respondent.

Q2 Record month, day and year of birth. Do not accept "I can't remember" as an answer. If R seems uncertain about his date of birth, suggest that he look at his driver's license. Write out the month; do not use a numerical value.

Q3 If R responds "single" probe to determine whether he has ever been married. "Single" may only be a response if R has never been married.

Q4 Record number of children. If R has no children record "0" in the blank. If R offers additional information regarding step and/or adopted children, note this in the white space below.

Q5 If no, go to Q6. If yes, record the number of years R has held a commercial fishing license. Next, obtain the span of years involved (i.e. "from 1959 to 1979") and probe for different periods of time. For example, if R has held a commercial fishing license for 20 years we need to know if he held that license for a consecutive 20 year period or if instead, he has held a license on and off for a total of 20 years (i.e. from 1950 to 1960; from 1965 to 1970, and from 1974 to 1979).

Q6&7 Same specifications as Q5

IF R ANSWERS NO TO Q5, 6, and 7, STOP THE INTERVIEW. TRY TO DETERMINE IF WE HAVE THE CORRECT RESPONDENT. THANK HIM FOR HIS TIME AND COOPERATION AND EXPLAIN THAT CURRENTLY WE ARE ONLY INTERVIEWING PEOPLE WHO HAVE COMMERCIALLY FISHED.

Q8 Ask as written. It is especially important to obtain the state where these towns are located.

Q8a Ask as written. A hailing port is where the fisherman docks his boat.

Q9 If no, go to Q10. If yes, record the number of years commercial fishing has been his full time occupation. Next, obtain the span of years involved (i.e. "from 1969 to 1979") and probe for different periods of time. For example, if R's full time occuaption was commercial fishing for 10 years, we need to know if this was a consecutive 10 year period of if instead, he has been a full time fisherman on and off for a total of 10 years (i.e. from 1959 to 1961; from 1971 to 1979).

Q10 Probe for specifics. If R holds a job which does not have a specific job title, ask for a description of the type of work. Probe to obtain a job title which reflects the type of work performed as accurately as possible. As a rule, one-word entries are usually inadequate. For example:

Inadequate	Specific
Factory worker	Electric motor assembler, forge heater, punch press operator, spray painter, turret lathe operator
Laborer	Sweeper, porter, janitor, window washer, hand trucker, stevedore
Foreman	Specify the craft or activity involved such as foreman carpente foreman truck driver, etc.

Q11 Same specifications as Q9.

Q12 Correct spelling and address information are imperative. Note that employment information requests both the number of years and actual years involved. Past interviewers report that it was easier and smoother to obtain all crew members' names first and then request each individual's address and work history.

Q13	Ask as written. Respondents usually answer with a weekly or monthly consumption pattern. If not , read the categories to hir probe to convert the consumption to weekly or monthly patterns.
Q14	Ask as written.
Q15	Ask as written.
Q16	Check all fish that R mentions. Be sure to record any and all other fish not listed under "Other."
Q17	We are interested in R's family's fish consumption in comparison to himself. For each family member, read the choices to R, starting with his wife. If R does not have a wife, check #4 "Does not apply." Blanks have been provided to record each son/daughter's consumption. Thus, if R has one daughter and two sons, the same information must be obtained for all three children. If R responds to items #2 or #3, record how often in the blank.
Q18	If no, go to Q18a. If yes, ask Q19-21 and record R's answers. Probe for as accurate as possible information from the respondent.
Q18a	If no, go to Q25. If yes, ask Q23-24. We are now interested in past smoking habits. Again, probe for as accurate as possible information from the respondent.
Q25-61	Same specifications as Q18-24.
Q62-104	This section of the questionnaire identifies 32 specific diseases. For each of the diseases, R's response should indicate whether he, his wife, or his children have been told by a doctor that he or they had this disease. It is very important that a positive response from R be based on a doctor's diagnosis and not on his own suspicions. The diseases are broken up into groups, i.e. lung diseases, liver diseases, etc.

Starting with Q62, pronounce each disease slowly and clearly. After each disease, pause long enough for R to respond. If R says no, record "1" in column one. If R says yes, record "2" in column one and obtain the following information:

Column 2:	Family member with disease (S=self; W=wife; Son; D=daughter)
Column 3:	Full name and address of the diagnosing and treating doctors. If R cannot remember the doctor's name, ask for the clinic or medical group. Try to obtain as specific an address as possible
Column 4:	Date of diagnosis

If R is unsure record "3" in first column.

Q105-125 This section of the questionnaire concerns symptoms the respondent has experienced only. Starting with Q112, read each symptom. Pause long enough for R to respond. If R says no, record "1" in column one. If R says yes, record "2" in column one and obtain the following information:

Column 2:	How frequently does/did the symptom occur—record in days, months, or years
Column 3:	How long do/did the symptoms last--record in days, months, or years
Coulmn 4:	Did R consult a doctor? 1=No 2=Yes 3=DK
Column 5:	Year R most recently experienced the symptom

If R is unsure, record "3" in column one.

Q126 Ask as written.

THANK THE RESPONDENT FOR HIS TIME AND COOPERATION. EXPLAIN THAT THE LAST PORTION OF THE QUESTIONNAIRE SHOULD BE ANSWERED BY HIS WIFE. IF THE RESPONDENT"S WIFE IS DECEASED, THESE QUESTIONS SHOULD THEN BE ANSWERED BY THE RESPONDENT TO THE BEST OF HIS ABILITY.

Q127 Record R's answer; natural children only. If R has no natural children record "0" in the blank.

Q128 Record R's answer; step or adopted children only. If R has no step or adopted children record "0" in the blank.

Q129 In this section we are interested only in R's pregnancies with the commercial fisherman. Pregnancies from a previous marraige should not be included. For each pregnancy, in the order they occurred, record the following:

Column 2: Briefly describe any complications R experienced during her pregnancy. (e.g. excessive bleeding, breech birth, etc.) If R experienced no complications record "None."

Column 3: Check the appropriate box for the outcome of the pregnancy

Column 7: Check appropriate box for infant's sex

Column 8: Date of infant's birth

Column 9: Live birth weight

Column 10: Full name and address of hospital, clinic, or other place of birth. Obatin as specific an address as possible

Column 11: Record attending doctor's full name

Q129a If R answers no, go to Q130. If R answers yes, obtain the following information:

Column 1: Record M or F for sex of child

Column 2: Record date of birth

Column 3: Record date of death

Column 4: Record cause of death and city and state where death was reported

Q130 If R answers no, go to Q131. If R answers yes, obtain the following information for R or R's natural children, checking the appropriate boxes from left to right. Record R's description of the birth defect in the last column (i.e. cleft palate, mongoloidism, etc).

Q131 Check appropriate box. If R answers no, proceed to next question. If R answers yes, go to Q132.

Q131a If R answers yes, go to Q134. If R answers no, proceed to next question.

Q132 Check the birth control method most used during R's adult life.

Q133 Record age at which R began to use birth control methods.

Q134 Record age at which R began to menstruate.

Q135 If R answers no, go to Q137. If R answers yes, proceed to next question.

Q136 Check appropriate answer. If cessation occurred due to surgery, obtain reason for surgery and full name and address of doctor. As always, obtain as specific as possible information.

Q137 If R answers yes, record medications prescribed by a doctor. If R cannot remember the name of the medications, suggest that she look at the bottles. If she does not have the bottles, record DK and collect any other information possible---reason she takes medication, how often she takes it, etc.

Q138 Ask as written.

Q139 Ask as written.

Q140 Read the question and choices to R. Check appropriate response.

Q141 If R answers no, go to Q143. If R answers yes, proceed to next question.

Q142 If R answers no, proceed to next question. If R answers yes, obtain doctor's full name and address.

Q143 Same specifications as Q137.

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Page 22: Observations by the Interviewer

These observations are to be recorded by the interviewer immediately following the interview. While Q1 and Q2 are strictly informational, Q3 and Q4 call for the interviewer's judgement. If you have difficulty in making these judgements in the precoded terms, please write out your comments and impressions in the Comments section below.

NON-INTERVIEW REPORT

GREAT LAKES FISHERMEN HEALTH STUDY

Respondent Name: ____________________ Interviewer Name: ____________________

I.D.#: ____________________ Date: ____________________

- * A Non-Interview Report must be completed if the result of the contact is "First Refusal", "Second Refusal", "Unavailable", "Other".
- * A Non-Interview Report must be completed if the result of the contact is "Respondent Moved" and the assignment is being turned in to the supervisor.
- * A Non-Interview Report must be completed when an incomplete assignment is returned after 12 or more contact attempts.

CIRCLE APPROPRIATE NUMBER

1. With whom did you speak? (FINAL CALL)

Respondent..................1
Other household member
(SPECIFY)........2
____
Neighbor....................3
Other (SPECIFY) ____________4
No one......................5

2. What is the result of the contact for this assignment? Please circle appropriate number.

1 First/Second Refusal...... (Q3)
2 Unavailable............... (Q8)
3 Respondent Moved.......... (Q11)
4 Other..................... (Q14)
5 Maximum Calls............. (Q16)

Q3–Q7 For REFUSALS only. PLEASE CHECK WHETHER THIS IS A FIRST OR SECOND REFUSAL

FIRST REFUSAL ________
SECOND REFUSAL ________

3. What were the reasons given for the refusal?

____

____

____

4. What do you think was the primary reason given for the refusal?

____

____

____

5. Was the refusal hostile, firm but NOT hostile, or mild?

Hostile.................	1	(End)
Firm....................	2	(Q.6)
Mild....................	3	(Q.6)

6. Do you think another interviewer might be able to obtain the interview?

Yes.....................	1	(Q.7)
No......................	2	(End)
Perhaps.................	3	(Q.7)

7. What type of interviewer do you think might be able to obtain the interview?

____

____

____

END

Q8-10 For UNAVAILABLES only.

8. Why was the respondent unavailable? (e.g. no show, disconnected phone, respondent deceased, etc.)

____

____

9. When will the repsondent be available for an interview?

____

10. Do you think there were other reasons for the non-interview? (e.g. a polite refusal) If so, specify:

____

____

END

Q11-13 For RESPONDENT MOVED only.

11. How did you determine that the respondent had moved?

____

____

12. Did you obtain a new address?

Yes..................1 (Q13)
No...................2 (End)

13. What is the respondent's new address?

____
(Number) (Street)

____
(City) (State) (Zip)

____
(Phone)

END

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Q14-15 For OTHER only.

14. Explain fully the circumstances involved. (e.g. language problem, evasive or suspicious, drunk or intoxicated, respondent was never a commercial fisherman, etc.)

____

____

____

____

15. Would you suggest any special action for this assignment? If so, specify:

____

____

END

Q16-18 For MAXIMUM CALLS only.

16. How many attempts did you make to reach the respondent?

Number of telephone attempts............ ________

17. Did you ever speak to anyone in the respondent's household?

Yes......................1 (Q18)
No.......................2 (End)

18. With whom did you speak and what was (were) the result(s) of your contacts?

Respondent................1
Other household member....2
(SPECIFY) ____________
Other (SPECIFY)...........3
____

Result:

____

____

____

END

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APPENDIX IV

Proposed Set of Coding Instructions

Coding Instructions
Great Lakes Fishermen Health Survey

The response materials for the Great Lakes Fishermen Health Survey will consist of three records per study subject. The first record will consist of the non-interview report materials which have a possible total of 150 characters. The second record will consist of the responses for the first half of the interview. Specifically, those questions directed toward the commercial fishermen (licensee). This record has a possible total of 503 characters. The third record will consist of the responses for the second half of the interview. Specifically, those questions directed toward the spouse of the commercial fisherman. This record has a possible total of 89 characters.

Unless otherwise specified, responses indicating a "don't know" answer should be coded as a -1. Coding space should remain blank in instances where no information is available (i.e. a blank response space). In instances where an answer requires less coding space than that provided, the spaces to the left should be filled with zeros (e.g. three spaces provided, answer is 9 = 0 0 9).

Partial information, at a minimum, must include a name and city/state of residence.

Record I
(Non-Interview Report)

All non-interview reports for each study subject should be coded. Space is provided on the coding sheet for five non-interview reports per study subject. Note that the subject ID number is not repeated when more than one non-interview report is filed per subject.

1. Study subject ID number.

   __ __ __ __ __ five digit code

   Each study subject will receive a five digit identification number.

2. Interviewer ID number.

   __ __ two digit code

   Each interviewer will receive a two digit identification number.

3. Date of non-interview report.

   __ __/__ __/__ __ six digit code

   Code exact month, day and the last two digits of the year.

4. (Question 1). Contact status at the time of call.

   __ single digit code

   1 = respondent
   2 = other household member
   3 = neighbor
   4 = other
   5 = no one

5. (Question 2). Result of the contact for the assignment.

   __ single digit code

   1 = first refusal
   2 = second refusal
   3 = unavailable
   4 = respondent moved
   5 = other
   6 = maximum number of calls

   NOTE: If "maximum number of calls" is coded than Questions 16-18 should be coded. Questions 3-15 should be blank.

6. (Question 3). Reason for refusal.

   __/__/__ three digit code

   First digit corresponds to a reason of "not interested".
   Second digit corresponds to a reason of "not available at the time of call".
   Third digit corresponds to "other" reason.

   Code "1" if mentioned as a reason for refusal.
   Code "0" if not mentioned as a reason for refusal.

7. (Question 4). Primary reason for refusal.

__/__/__ three digit code

First digit corresponds to a reason of "not interested".
Second digit corresponds to a reason of "not available at the time of call".
Third digit corresponds to an "other" reason.

Code "1" if mentioned as a reason for refusal.
Code "0" if not mentioned as a reason for refusal.

8. (Question 5). Type of refusal.

__ single digit code

1 = hostile

2 = firm

3 = mild

Code type of refusal indicated by interviewer.

9. (Question 6). Interviewer determination if subject interview is obtainable by means of another interviewer.

__ single digit code

1 = no

2 = yes

3 = perhaps

10. (Question 8). Reasons why study subject was unavailable at the time of call.

__/__/__/__/__ five digit code

First digit corresponds to "not home at time of call".
Second digit corresponds to "study subject has moved".
Third digit corresponds to "study subject is deceased".
Fourth digit corresponds to "phone has been disconnected".
Fifth digit corresponds to "other".

Code "1" if determined as a reason why subject was unavailable.
Code "0" if not determined as a reason why subject was unavailable.

NOTE: Question 8 should only be coded when the answer to Question 2 is "unavailable". (i.e., "3").

11. (Question 12). Was a new address obtained.

__ single digit code

1 = no

2 = yes

NOTE: Question 12 should only be coded when the answer to Question 2 is "respondent moved". (i.e., 4).

12. (Question 14). "Other" reasons for non-interview report.

__ __ two digit code

Code the total number of "other" reasons written by interviewer.

13. (Question 16). How many attempts did you make to reach subject.

__ __ two digit code

Code number of attempts written by interviewer.

NOTE: Question 16 should only be coded when the answer to Question 2 is "maximum calls". (i.e., 6).

14. (Question 17). Did interviewer speak to any household member.

__ single digit code

1 = no

2 = yes

Record I

First Non-Interview Report.

1. __ __ __ __ __ __
2. __ __
3. __ __/__ __/__ __
4. (Question 1) __
5. (Question 2) __
6. (Question 3) __/__/__
7. (Question 4) __/__/__
8. (Question 5) __
9. (Question 6) __
10. (Question 8) __/__/__/__/__
11. (Question 12) __
12. (Question 14) __ __
13. (Question 16) __ __
14. (Question 17) __

(34 Characters) Total = 34 Characters

Second Non-Interview Report.

2. __ __
3. __ __/__ __/__ __
4. (Question 1) __
5. (Question 2) __
6. (Question 3) __/__/__
7. (Question 4) __/__/__
8. (Question 5) __
9. (Question 6) __
10. (Question 8) __/__/__/__/__

11. (Question 12) _

13. (Question 16) _ _

14. (Question 17) _

(29 Characters) Total = 63 Characters

Third Non-Interview Report.

2. _ _
3. _ _/_ _/_ _
4. _
5. _
6. _/_/_
7. _/_/_
8. _
9. _
10. _/_/_/_/_
11. _
12. _ _
13. _ _
14. _

(29 Characters) Total = 92 Characters

Fourth Non-Interview Report.

2. _ _
3. _ _/_ _/_ _
4. _
5. _
6. _/_/_
7. _/_/_
8. _
9. _

10. _/_/_/_/_

11. _

12. _ _

13. _ _

14. _

(29 Characters) Total = 121 Characters

Fifth Non-Interview Report

2. _ _

3. _ _/_ _/_ _

4. (Question 1) _

5. (Question 2) _

6. (Question 3) _/_/_

7. (Question 4) _/_/_

8. (Question 5) _

9. (Question 6) _

10. (Question 8) _/_/_/_/_

11. (Question 12) _

12. (Question 14) _ _

13. (Question 16) _ _

14. (Question 17) _

(29 Characters) Total = 150 Characters

Subject ID number __

Name of coder __

Date ___________

Record II
Great Lakes Fishermen Health Survey

1. Study subject ID number.

   __ __ __ __ __ five digit code

   Each subject will receive a five digit identification number.

2. Interviewer ID number.

   __ __ two digit code

   Each interviewer will receive a two digit identification number.

3. Length of interview.

   __ __ __ three digit code

   The length of time required for the interview will be calculated by the coder. Code the length of time in minutes.

4. (Question 2). Birthdate of respondent.

   __ __/__ __/__ __ six digit code

   Code month, day, and the last two digits of the year.

5. (Question 3). Marital status of respondent.

   __ single digit code

   1 = single (never married)
   3 = separated or divorced
   2 = married
   4 = widowed

6. (Question 126). Sex of respondent.

   __ single digit code

   1 = male
   2 = female

7. (Question 4). Number of children of study respondent.

   __/__ two digit code

   First digit corresponds to the number of sons.
   Second digit corresponds to the number of daughters.

8. (Question 5). Does respondent currently own a commercial fishing license.

   __/__/__ __ four digit code

   First digit corresponds to the direct answer of Question 5.

   1 = no
   2 = yes

   Second digit corresponds to the number of different periods of time the respondent has held a commercial fishing license.

Third and fourth digits correspond to the total number of years the study participant has held a license.

NOTE: If the first digit is "1" corresponding to a "no" answer, than the remaining spaces should be blank.

9. (Question 6). Did respondent ever hold a commercial fishing license.

__/__/__ __ four digit code

Coding instructions identical to those presented for number 8 (Question 5).

10. (Question 7). Did respondent ever crew or be a partner with an individual owning a commercial fishing license.

__/__/__ __ four digit code

Coding instructions identical to those presented for number 8 (Question 5).

NOTE: If Question 5-7 have been answered "no", than the rest of Record II and Record III (coding spaces) are blank.

11. (Question 8). Lake and surrounding land masses will be stratified into segments.

__/__ two digit code

First digit corresponds to the Lake.

1 = Superior
2 = Michigan
3 = Huron
4 = Erie
5 = Ontario

Second digit corresponds to the lake segment.

NOTE: See appendices for lake stratifications.

12. (Question 9). Is commercial fishing respondents current full-time occupation.

__/__/__ __ four digit code

Coding instructions are identical to those presented for number 8 (Question 5).

13. (Question 10). Current full-time occupation of respondent.

__ single digit code

1 = Occupation known to have potential exposure to hazardous materials.
2 = Occupation subject to have potential exposure to hazardous materials.
3 = Occupation not known to have potential exposure to hazardous materials.
4 = Occupation unclassifiable.

NOTE: See appendices for classification of occupations.

14. (Question 11). Was commercial fishing ever respondents full-time occupation.

__/__/__ __ four digit code

Coding instructions are identical to those provide for number 8 (Question 5).

15. (Question 12). Total number of names/addresses of full- or part-time crew members.

__ __ two digit code

Code number of names/addresses obtained from respondent.

NOTE: Partial information should be coded as if the information were complete.

16. (Question 13). How many times does respondent consume Great Lakes fish.

__ single digit code

1 = never
2 = 1-2 times per week
3 = 3-5 times per week
4 = 6-7 times per week
5 = 1 time per month
6 = 1 time per month
7 = 2-3 times per month

17. (Question 14). How many years has respondent consumed Great Lakes fish with this frequency.

__ __ two digit code

Code number of years given by respondent.

18. (Question 15). How many pounds of fish does study participant consume per meal.

__ single digit code

Code response in terms of pounds of fish per meal. The response can be coded in terms of a fraction of a pound.

19. (Question 16). What types of Great Lakes fish does respondent consume most often.

__/__/__/__/__/__/__/__/__/__/__/__/__/__/__ fifteen digit code.

0 = not mentioned by respondent
1 = mentioned by respondent

First digit = salmon
Second digit = perch
Third digit = walleye
Fourth digit = burbot
Fifth digit = rough fish
Sixth digit = chub
Seventh digit = northern pike
Eighth digit = lake whitefish
Ninth digit = lake trout
Tenth digit = smelt
Eleventh digit = bass
Twelveth digit = lake herring
Thirteenth digit = pan fish
Fourteenth digit = other trout
Fifteenth digit = other

NOTE: All spaces provided should be coded with either a "0" or a "1".

20. (Question 17). How often do the family members of respondent consume fish.

__/__/__/__/__/__ six digit code

First digit corresponds to the consumption patterns of the spouse.

1 = as often as respondent
2 = more often than respondent
3 = less often than respondent
4 = does not apply
5 = never

Second-sixth digits are for additional family members when appropriate.

NOTE: Spaces should be left blank if there are no family members and should be coded with a "-1" in those instances where a "don't know" is given as a response.

(Question 18-24). Cigarette smoking history.

21. __/__ two digit code

First digit corresponds to whether or not the respondent smokes cigarettes currently.
Second digit corresponds to whether or not the respondent smoke cigarettes in the past.

1 = no
2 = yes

NOTE: Both digits should be coded. If both digits correspond to "no" than the coding spaces for 21a should remain blank. If either of the digits correspond to "yes" than the spaces for 21a should be coded.

21a. __ __/__ __/__ __ six digit code

First and second digits correspond to the age at which the respondent began to smoke cigarettes.
Third and fourth digits correspond to the average number of cigarettes the respondent smokes (had smoked) per day.
Fifth and sixth digits correspond to the number of years the respondnet smoked cigarettes (with this frequency).

NOTE: Twenty-one a should be blank if 21 is coded 1/1. Twenty-one a should be coded if either digit in 21 is coded with a "2".

(Question 25-31). Pipe smoking history.

22. __/__ two digit code

First digit corresponds to whether or not respondent smokes a pipe regularly.
Second digit corresponds to whether or not respondent smoked a pipe in the past.

1 = no
2 = yes

NOTE: Both digits should be coded. If both digits are answered "no" than the coding spaces for 22a should remain blank. If either of the digits correspond to "yes", than the spaces for 21a should be coded.

22a. __ __/__ __/__ __ six digit code

First and second digits correspond to the age at which respondent began to smoke a pipe.

Third and fourth digits correspond to the number of pipefuls the respondent smokes (had smoked) per day.

Fifth and sixth digits correspond to the number of years the respondent smoked a pipe (with this frequency).

NOTE: Twenty-two a should be blank if 22 is coded 1/1. Twenty-two a should be coded if either digit in 21 is coded with a "2".

(Questions 32-38). Cigar smoking history.

23. __/__ two digit code

First digit corresponds to whether or not the respondent smokes cigars currently.

Second digit corresponds to whether or not the respondent smoked cigars in the past.

1 = no

2 = yes

NOTE: Both digits should be coded. If both digits correspond to a "no" than the coding spaces for 23a should remain blank. If either of the digits correspond to "yes" than the spaces for 23a should be coded.

23a. __ __/__ __/__ __ six digit code

First and second digits correspond to the age at which the respondent began to smoke cigars.

Third and fourth digits correspond to the average number of cigars the respondent smokes (had smoked) per day.

Fifth and sixth digits correspond to the number of years the respondent smoked cigars (with this frequency).

NOTE: Twenty-three a should be blank if 23 is coded 1/1. Twenty-three a should be coded if either digit in 23 is coded with a "2".

24. (Question 39). Has the respondent ever chewed tobacco regularly.

__ single digit code

1 = no

2 = yes

25. (Question 40). Has the respondent ever used snuff regularly.

__ single digit code

1 = no

2 = yes

(Question 41-47). Liquor drinking history.

26. __/__ two digit code

First digit corresponds to whether or not the respondent drinks liquor regularly.

Second digit corresponds to whether or not the respondent drank liquor in the past.

1 = no

2 = yes

NOTE: Both digits should be coded. If both digits correspond to "no", than the coding spaces for 26a should remain blank. If either of the digits correspond to "yes" than the spaces for 26a should be coded.

26a. __ __/__ __/__ __ six digit code

First and second digits correspond to the age at which the respondent began to drink liquor.
Third and fourth digits correspond to the average number of hard liquor drinks the respondent consumes (had consumed) per week.
Fifth and sixth digits correspond to the number of years the respondent drank hard liquor (with this frequency).

NOTE: Twenty-six a should be blank if 26 is coded 1/1. Twenty-six a should be coded if either digit in 26 is coded with a "2".

(Questions 48-54). Beer drinking history.

27. __/__ two digit code

First digit corresponds to whether or not the respondent drinks beer currently.
Second digit corresponds to whether or not the respondent drank beer in the past.

1 = no

2 = yes

NOTE: Both digits should be coded. If both digits correspond to "no", than the coding spaces for 27a should remain blank. If either of the digits correspond to "yes", than the spaces for 27a should be coded.

27a. __ __/__ __/__ __ six digit code

First and second digits correspond to the age at which respondent began to drink beer.
Third and fourth digits correspond to the number of beers the respondent drinks (had drunk) per week.
Fifth and sixth digits correspond to the number of years the respondent drank beer (with this frequency).

NOTE: Twenty-seven a should be blank if 27 is coded 1/1. Twenty-seven a should be coded if either digit in 27 is coded with a "2".

(Questions 55-61). Wine drinking history.

28. __/__ two digit code

First digit corresponds to whether or not the respondent drinks wine currently.
Second digit corresponds to whether or not the reposondent drank wine in the past.

1 = no

2 = yes

NOTE: Both digits should be coded. If both digits correspond to "no" than the coding spaces for 28a should remain blank. If either of the digits correspond to "yes", than the spaces for 28a should be coded.

28a. __ __/__ __/__ __ six digit code

First and second digits correspond to the age at which respondent began to drink wine.
Third and fourth digits correspond to the number of wine drinks the respondent consumes (had consumed) per week.
Fifth and sixth digits correspond to the number of years the respondent drank wine (with this frequency).

NOTE: Twenty-eight a should be blank if 28 is coded 1 / 1. Twenty-eight a should be coded if either digit in twenty-eight is coded with a "2".

(Questions 62-105). Familial medical conditions of respondent.

29. __/__/__/__/__ five digit code

First digit corresponds to the acknowledgement of a disease/condition variable within the family.

1 = no

2 = yes

NOTE: If the first digit is coded with a "1" than the remaining coding spaces should remain blank. If the first digit is coded with a "2", than the remaining digits must be coded.

Second digit corresponds to the family member with the disease/condition.

1 = self

2 = spouse

3 = son

4 = daughter

Third digit corresponds to whether or not information is provided regarding the name(s) and address(es) of medical personnel and/or service. Partial information should be coded as if information were complete.

1 = no

2 = yes

-1 = don't know (no information given)

Fourth digit corresponds to whether or not information is provided regarding the date of diagnosis. Partial information should be coded as if information were complete.

1 = no

2 = yes

-1 = don't know (no information given)

Fifth digit corresponds to whether or not the disease/condition was verified by medical record.

1 = no

2 = yes

NOTE: The five digit coding sequence (i.e., __/__/__/__/__) and the instructions for each of the digits are to be used for Questions 62-104.

(Question 105-125). Symptomatology of respondent.

72. _/_/_/_/_/_ _/_ eight digit code

First digit corresponds to the acknowledgement of a symptom experienced by by the respondent.

1 = no

2 = yes

NOTE: If the first digit is coded with a "1" than the remaining coding spaces should remain blank. If the first digit is coded with a "2", than the remaining digits must be coded.

Second digit corresponds to whether or not information regarding the frequency of symptoms was given by the respondent.

1 = no

2 = yes

-1 = don't know

Third digit corresponds to whether or not information regarding the duration of symptoms was given by the respondent.

1 = no

2 = yes

-1 = don't know

Fourth digit corresponds to whether or not respondent consulted a physician.

1 = no

2 = yes

NOTE: If the fourth digit is coded with a "1" than the remaining digits should be blank. If the fourth digit is coded with a "2", than the fifth through eighth digits must be coded.

Fifth digit corresponds to whether or not information is provided regarding the name(s)/address(es) of medical personnel and/or service. Partial information should be coded as if the information were complete.

1 = no

2 = yes

-1 = don't know

Sixth and seventh digits correspond to the last two digits of the year the symptom was most recently experienced (e.g., 1979 = 7 9). Code -1 -1 if respondent doesn't know.

Eighth digit corresponds to whether or not the symptom was verified by medical record.

1 = no

2 = yes

NOTE: The eight digit coding sequence (i.e., _/_/_/_/_/_/_ _) and the instructions for each of the digits are to be used for Questions 105-125.

Record II

1. __ __ __ __ __

2. __ __

3. __ __ __

(Question 2) 4. __ __/__ __/__ __

(Question 3) 5. __

(Question 126) 6. __

(Question 4) 7. __/__

(Question 5) 8. __/__/__ __

(Question 6) 9. __/__/__ __

(Question 7) 10. __/__/__ __

(Question 8) 11. __/__

(Question 9) 12. __/__/__ __

(Question 10) 13. __

(Question 11) 14. __/__/__ __

(Question 12) 15. __ __

(Question 13) 16. __

(Question 14) 17. __ __

(Question 15) 18. __

(Question 16) 19. __/__/__/__/__/__/__/__/__/__/__/__/__/__/__

(Question 17) 20. __/__/__/__/__/__

(Question 18-24) < 21. __/__

21a. __ __/__ __/__

(Question 25-31) < 22. __/__

22a. __ __/__ __/__ __

(Question 32-38) < 23. __/__

23a. __ __/__ __/__ __

(Question 39) 24. _

(Question 40) 25. _

(Question 41-47) 26. _/_

26a. _ _/_ _/_ _

(Question 48-54) 27. _/_

27a. _ _/_ _/_ _

(Question 55-61) 28. _/_

28a. _ _/_ _/_ _

(Question 62) 29. _/_/_/_/_

(Question 63) 30. _/_/_/_/_

(Question 64) 31. _/_/_/_/_

(Question 65) 32. _/_/_/_/_

(Question 66) 33. _/_/_/_/_

(Question 67) 34. _/_/_/_/_

(Question 68) 35. _/_/_/_/_

(Question 69) 36. _/_/_/_/_

(Question 70) 37. _/_/_/_/_

(Question 71) 38. _/_/_/_/_

(Question 72) 39. _/_/_/_/_

(Question 73) 40. _/_/_/_/_

(Question 74) 41. _/_/_/_/_

(Question 75) 42. _/_/_/_/_

(Question 76) 43. _/_/_/_/_

(Question 77) 44. _/_/_/_/_

(Question 78) 45. _/_/_/_/_

(Question 79) 46. _/_/_/_/_

(Question 80) 47. _/_/_/_/_

(Question 81) 48. _/_/_/_/_

(Question 82) 49. _/_/_/_/_

(Question 83) 50. _/_/_/_/_
(Question 84) 51. _/_/_/_/_
(Question 85) 52. _/_/_/_/_
(Question 86) 53. _/_/_/_/_
(Question 87) 54. _/_/_/_/_
(Question 88) 55. _/_/_/_/_
(Question 89) 56. _/_/_/_/_
(Question 90) 57. _/_/_/_/_
(Question 91) 58. _/_/_/_/_
(Question 92) 59. _/_/_/_/_
(Question 93) 60. _/_/_/_/_
(Question 94) 61. _/_/_/_/_
(Question 95) 62. _/_/_/_/_
(Question 96) 63. _/_/_/_/_
(Question 97) 64. _/_/_/_/_
(Question 98) 65. _/_/_/_/_
(Question 99) 66. _/_/_/_/_
(Question 100) 67. _/_/_/_/_
(Question 101) 68. _/_/_/_/_
(Question 102) 69. _/_/_/_/_
(Question 103) 70. _/_/_/_/_
(Question 104) 71. _/_/_/_/_
(Question 105) 72. _/_/_/_/_/_/_/_/_
(Question 106) 73. _/_/_/_/_/_/_/_/_
(Question 107) 74. _/_/_/_/_/_/_/_/_
(Question 108) 75. _/_/_/_/_/_/_/_/_
(Question 109) 76. _/_/_/_/_/_/_/_/_
(Question 110) 77. _/_/_/_/_/_/_/_/_
(Question 111) 78. _/_/_/_/_/_/_/_/_

400

(Question 112) 79. _/_/_/_/_/_/_/_

(Question 113) 80. _/_/_/_/_/_/_/_

(Question 114) 81. _/_/_/_/_/_/_/_

(Question 115) 82. _/_/_/_/_/_/_/_

(Question 116) 83. _/_/_/_/_/_/_/_

(Question 117) 84. _/_/_/_/_/_/_/_

(Question 118) 85. _/_/_/_/_/_/_/_

(Question 119) 86. _/_/_/_/_/_/_/_

(Question 120) 87. _/_/_/_/_/_/_/_

(Question 121) 88. _/_/_/_/_/_/_/_

(Question 122) 89. _/_/_/_/_/_/_/_

(Question 123) 90. _/_/_/_/_/_/_/_

(Question 124) 91. _/_/_/_/_/_/_/_

(Question 125) 92. _/_/_/_/_/_/_/_

Total = 503 Characters

Record III
Great Lakes Fishermen Health Survey

93. (Question 127). Number of natural children of the respondent.

__ __ two digit code

Code number of children given by respondent.

94. (Question 128). Number of step or adopted children of the respondent.

__ __ two digit code

Code number of children given by respondent.

95-100. (Question 129). Information regarding pregnancies and pregnancy outcomes of respondent.

__/__/__/__/__/__/__/__/__/__ nine digit code

First digit corresponds to the order of pregnancies of the respondent. (e.g., Third pregnancy = 3).
Second digit corresponds to whether or not there were any complications during this pregnancy.

1 = no

2 = yes

Third digit corresponds to the outcome of the pregnancy.

1 = miscarriage

2 = stillbirth

3 = live birth

4 = other (abortion)

NOTE: If the third digit is coded "1" or "4" than the fourth, fifth, and sixth digits should be blank.

Fourth digit corresponds to the infants sex.

1 = male

2 = female

Fifth digit corresponds to whether or not a date of birth is provided by the respondent.

1 = no

2 = yes

Sixth digit corresponds to whether or not a live birth weight is provided by the respondent.

1 = no

2 = yes

NOTE: The third digit must be coded with a "2". If the third digit is coded with a number other than a "2" than this space should be blank.

Seventh digit corresponds to whether or not information is provided regarding the name(s)/address(es) of hospital or place of birth.

1 = no

2 = yes

-1 = don't know

Eighth digit corresponds to whether or not information is provided regarding the name(s) of the attending physician(s).

1 = no

2 = yes

-1 = don't know

Ninth digit corresponds to whether or not the pregnancy and outcome was verified by medical record.

1 = no

2 = yes

NOTE: There are spaces provided for six pregnancies on the coding sheet. If more than six pregnancies, code the first six pregnancies listed on the questionnaire.

101. (Question 129a).

__/__/__ three digit code

First digit corresponds to whether or not any of the respondents natural children have died.

1 = no

2 = yes

NOTE: If the first digit is coded "1" than the second and third digits should be blank. If the first digit is coded with a "2" than the second and third digits must be coded.

Second digit corresponds to whether or not any information regarding the child's sex, date of birth, date of death, name, cause of death, and the city and state in which the death was reported.

1 = no

2 = yes

NOTE: Partial information should be considered as a "yes" answer. The most important pieces of information are the name of the child and the city and state in which the death was reported.

Third digit corresponds to whether or not the death certificate was obtained from the respective state agency.

1 = no

2 = yes

102. (Question 130).

__/__ two digit code

First digit corresponds to whether or not the respondent or any of the respondent's natural children have birth defects.

1 = no

2 = yes

NOTE: If the first digit is coded with a "1" than the second digit should remain blank. If the first digit is coded with a "2" than the second digit must be coded.

Second digit corresponds to whether or not information is provided regarding the relationship to the respondent, the current status (i.e., living or dead) of the individual, and the nature of the birth defect.

1 = no

2 = yes

NOTE: Partial information should be considered as a "yes" response. The most important piece of information is the nature of the birth defect.

103. (Questions 131-131a).

__/__ two digit code

First digit corresponds to whether or not the respondent uses a birth control method in the past.

1 = no

2 = yes

NOTE: Both spaces should be coded.

104. (Question 132). What method of birth control was most frequently used during the respondent's adult life.

__ single digit code

1 = pill
2 = I.U.D.
3 = diaphram
4 = foam or jelly
5 = rhythm
6 = condom
7 = two of the above
8 = other

105. (Question 133). Age at which respondent began to use birth control methods.

__/__ two digit code

Code age given by respondent.

106. (Question 134). At what age did the respondent begin to menstruate.

__/__ two digit code

107. (Questions 135-137).

__/__/__/__/__/__ six digit code

First digit corresponds to whether or not the respondent has stopped menstruating.

1 = no

2 = yes

NOTE: If the first digit is coded "1" than the second, third and fourth digits should remain blank. If the first digit is coded "2" than the remaining digits should be coded.

Second digit corresponds to whether the menstrual cessation was natural or due to surgery.

1 = natural

2 = surgery

NOTE: If the second digit is coded with a "1" than the third digit should be blank. If the second digit is coded with a "2" than the third digit should be coded.

Third digit corresponds to whether or not information is given regarding the reason for surgery and the attending physician's name and address.

1 = no

2 = yes

-1 = don't know

NOTE: Partial information should be considered as a "yes" response.

Fourth digit corresponds to whether or not the respondent to any medications since menstruation began.

1 = no

2 = yes

Fifth digit corresponds to whether or not information is provided regarding the names of the medication.

1 = no

2 = yes

NOTE: Partial information should be coded as a "yes" response.

Sixth digit corresponds to whether or not surgical cessation of menses was verified by medical record.

1 = no

2 = yes

108. (Question 138). What was the average number of days between the respondent's periods.

__ __ two digit code

Code average number of days.

109. (Question 139). What was the average length of the respondent's period.

__ __ two digit code

Code average number of days.

110. (Question 140). Has respondent's blood flow during menstruation changed in the [illegible]t five years.

__ single digit code

1 = increased

2 = decreased

3 = stayed the same

4 = does not apply

111. (Question 141).

__/__/__/__ four digit code

First digit corresponds to whether or not the respondent experience any spotting or bleeding between menstrual cycles.

1 = no

2 = yes

NOTE: If the first digit is coded with a "1" than the remaining spaces should be blank. If the first digit is coded as a "2" than the second digit must be coded.

Second digit corresponds to whether or not the respondent consulted a physician.

1 = no

2 = yes

NOTE: If the second digit is coded "1" than the remaining spaces should be blank. If the second digit is coded with a "2" than the remaining digits must be coded.

Third digit corresponds to whether or not information is provided regarding the name(s) and address(es) of physicians consulted for this problem.

1 = no

2 = yes

NOTE: Partial information should be considered as a "yes" response.

Fourth digit corresponds to whether or not respondent's condition was verified by medical record.

1 = no

2 = yes

112. (Question 143).

__/__ two digit code

First digit corresponds to whether or not the respondent used medications for menstrual irregularities.

1 = no

2 = yes

Second digit corresponds to whether or not information is provided by respondent regarding the name(s) of the medication(s).

1 = no

2 = yes

-1 = don't know

NOTE: Second digit should be blank if the first digit is coded with a "1".

113. (Questions 1-126). Were answered by:

__ single digit code

1 = study subject

2 = spouse of study subject

3 = other

114. (Questions 127-143). Were answered by:

__ single digit code

1 = study subject

2 = spouse of study subject

3 = other

Record III

(Question 127)	93.	_ _
(Question 128)	94.	_ _
(Question 129)	95.	_/_/_/_/_/_/_/_/_
	96.	_/_/_/_/_/_/_/_/_
	97.	_/_/_/_/_/_/_/_/_
	98.	_/_/_/_/_/_/_/_/_
	99.	_/_/_/_/_/_/_/_/_
	100.	_/_/_/_/_/_/_/_/_
(Question 129a)	101.	_/_/_
(Question 130)	102.	_/_
(Question 131-131a)	103.	_/_
(Question 132)	104.	_
(Question 133)	105.	_ _
(Question 134)	106.	_ _
(Question 135-137)	107.	_/_/_/_/_/_
(Question 138)	108.	_ _
(Question 139)	109.	_ _
(Question 140)	110.	_
(Question 141-142)	111.	_/_/_/_
(Question 143)	112.	_/_
	113.	_
	114.	_

Total = 89 Characters

CODES TO BE USED FOR OCCUPATIONS (QUESTION 10)

01 = Professional

02 = Officials and Managers

03 = Sales Workers

04 = Clerical Workers

05 = Craftsmen

06 = Foremen

07 = Operatives - non transport

09 = Operatives - transport equipment

10 = Laborers - unskilled

11 = Unemployed

12 = Disabled

13 = Retired

88 = Not Reported

14 = Student

15 = Military

16 = Farm Managers or Farmers

17 = Service Workers (except Private Household Workers)

18 = Private Household Workers

U.S. Bureau of Census: 1970 Census of Population
Classified Index of Industries and Occupations.
U.S. Government Printing Office, Washington, D.C., 1971

CODES FOR CAUSES OF DEATH (QUESTION 129a)

01 = Diseases of heart

02 = Malignant neoplasms (tumor, leukemia, carcinoma)

03 = Cerebrovascular diseases

04 = Accidents

05 = Influenza and pneumonia

06 = Tuberculosis, all forms

07 = Diabetes mellitus

08 = Bronchitis, emphysema, and asthma

09 = Cirrhosis of liver

10 = Suicide

11 = Congenigal anomalies

12 = Homicide, War

13 = Nephritis and nephrosis

14 = Peptic ulcer, Hemorrhaging

15 = Other Vascular Diseases

16 = Old age

17 = Other - Alcoholism

99 = Unknown

CODES TO BE USED FOR BIRTH DEFECTS (QUESTION 130)

1 = Central nervous system -
  1=Anencephaly
  2=Spina Bifida
  3=Hydrocyphalus
  4=Microencephaly
  5=Encephalocele
  6=not specified

2 = Craniofacial -
  1=Cleft palate
  2=Cleft lip ± palate
  3=Congenital cataract
  4=Anopthalmus
  5=not specified

3 = Cardiovascular -
  1=Transposition
  2=Tetralogy
  3=Coarctation
  4=Ventricular septal defect
  5 not specified

4 = Gastrointestinal -
  1=Tracheo-esophageal atresias
  2=Small bowel atresias
  3=Anorectal atresias
  4=Pyloric stenosis
  5=Diaphramatic hernia
  6=Omphalocele
  7=not specified

5 = Genitourinary -
  1=Exstrophy of bladder
  2=Septic kidney disease
  3=Hypospadias
  4=not specified

6 = Musculoskeletal
  1=Club foot
  2=Reduction deformities
  3=Dislocated hips
  4=Polydactyly
  5=Syndactyly
  6=not specified

7 = Chromosomal -
  1=Down Syndrome
  2=Trisomy O
  3=Trisomy E
  4=not specified

Codes adapted from - Center for Disease Control: Congenital Malformations, Surveillance, July 1978 - June 1979, issued July 1980.

APPENDIX V

Proposed Set of Analytical Procedures
(appropriate for pilot questionnaires only)

Q1. Check answer against data file and correct data file if necessary.

Q2. Categorical response will be used to stratify participants in analysis. (e.g., search males for prostate cancer.) A frequency count to describe the cohort will be performed.

Q3. Categorical response will be used to stratify participants in analysis. (e.g., search Blacks for heart disease.) A frequency count to describe the cohort will be performed.

Q4. Birthdate will be utilized for:

a) determining age distribution of the cohort
b) determining age of the participant
c) to determine the age of the participants at the given life events of Q11, Q13, Q67, to Q118

Q5. Answer will be utilized to obtain medical records and death certificates when applicable.

6. Categorical response will be used to stratify participants in analysis. (e.g., search marrieds for lung cancers.) A frequency count to describe the cohort will be performed.

Q7. Answer will be used to determine years of possible exposure potential. Reliability will be determined by comparison with Q11, Q12, and Q13 and available state records.

Q8. Answer will be used to determine years of possible exposure potential. Reliability will be determined by comparison with Q11, Q12, and Q13 and available state records.

Q9. Answer will be used to determine years of possible exposure potential. Reliability will be determined by comparison with Q11, Q12, and Q13 and available state records.

NOTE: Q7, Q8, and Q9 will serve as exclusion criteria. If the answer is "no" for the three questions participants will be excluded from the analyses.

Q10. Each lake will be stratified into segments. Each segment will be environmentally characterized according to the degree of contamination with PCBs and other organics. Characterization will be based upon available environmental data regarding organics in water, sediments, and fish. Fishing location will be used to determine exposure potential.

Q10a. Answer will be used in conjunction with Q10 to determine expsure potential.

NOTE: Q10a is not found in Protocol III.

Q11. Answer will be used to determine years of possible exposure potential. Reliability will be determined by comparison with Q7, Q8, and Q9 and available state records.

Q12. Answer will be used to determine if a possible confounding exposure is occurring through a secondary occupation.

Q13. Answer will be used to determine years of possible exposure potential. Reliability will be determined by comparison with Q7, Q8, and Q9 and available state records.

Q14. Answer will be used to determine if sport fishing and potential sport fish consumption may be an additional route of exposure. A frequency distribution on this variable will be performed.

Q15. Answer will be used to determine if sport fishing and potential sport fish consumption may be an additional route of exposure. A frequency distribution on this variable will be performed.

Q16. Answer will be used to determine in which states and what types of waterbodies study participants sport fish.

Q17. Answer(s) will be:
   a) added to the data file for compiling a future cohort
   b) a frequency distribution will be compiled regarding the number of names listed per questionnaire.

Q18. Answer is a dichotomous variable that will be used to:
   a) serve as an exclusion criterion for Q19 to Q27
   b) determine a frequency distribution for the percent of this cohort reporting a possible exposure

Q19. Answer will provide a frequency distribution on the number of meals consumed containing Great Lakes fish. Participants will then be stratified on this variable to determine odds ratios for Q67 to Q118, and Q119 to Q140.

Q20. Answer will be used to determine the relative frequency of consumption for each type of fish from the Great Lakes. Participants will be stratified according to specific fish species consumed.

Q21. A frequency distribution will be compiled. This variable will then be stratified and used as a criterion for grouping participants by years of possible exposure for comparison against Q67 to Q118, and Q119 to Q149.

Q22. Answer will provide a frequency distribution on the number of meals consumed containing non-Great Lakes fish. Participants will then be stratified on this variable for determining ratios for Q67 to Q118, and Q119 to Q140. The answer will pertain to inland water fish meals as opposed to Great Lakes. In addition, this variable will be used to determine total potential exposure via fish consumption from any source.

Q23. Answer will be used to determine the relative frequency of consumption for each type of fish from inland waters. Participants will be stratified according to specific fish species consumed. In addition, this variable will be used to determine total consumption of specific fish species from any source.

Q24. A frequency distribution will be compiled. This variable will then be stratified and used as a criterion for grouping participants by years of possible exposure for comparison against Q67 to Q118, and Q119 to Q140. In addition, this variable will be used to determine total potential exposure via fish consumption.

Q25. Frequency counts will be made separately for wives, sons, and daughters. Stratifications performed in Q19 and Q22 will be compared with the three frequency counts to determine potential family member exposures via fish consumption.

Q26. A frequency distribution will be calculated for the entire cohort. Reliability will be determined by comparisons with Q19 and Q22. Subjects will then be stratified by this variagle for morbidity analysis with Q67 to Q118, and Q119 to Q140.

Q27. A frequency distribution will be calculated for the entire cohort as well as for the various levels of stratification in Q20 and Q23.

Q28. Answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q29. This answer will be used to determine years of exposure to cigarettes (i.e., smoking history). A frequency distribution will be calculated.

Q30. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding high, medium, and low levels of consumption and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q31. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years smoked and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q32. This question is to aid the participant in answering Q33. A frequency distribution will be calculated.

Q33. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years smoked and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q34. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, lsited in Q67 to Q118, and Q119 to Q140.

Q34a. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q35. This answer will be used to determine years of exposure to pipes (i.e., smoking history). A frequency of distribution will be calculated.

Q36. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding high, medium, and low levels of consumption and the prevalence of a morbid condition listed in Q67 to Q118 and Q119 to Q140.

Q37. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years smoked and the prevalence of a morbid condition listed in Q67to Q118, and Q119 to Q140.

Q38. This question is to aid the participant in answering Q39. A frequency distribution will be calculated.

Q39. This answer will be used to establish a frequency count. Risk ratios will be claculated regarding the number of years smoked and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q40. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q40a. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q41. This answer will be used to determine years of exposure to cigars (i.e., smoking history). A frequency distribution will be calculated.

Q42. This anser will be used to establish a frequency count. Risk ratios will be calculated regarding high, medium, and low levels of consumption and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q43. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years smoked and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q44. This question is to aid the participant in answering Q45. A frequency distribution will be calculated.

Q45. This answer will be used to establish a frequency count. Risk ratios will be claculated regarding the number of years smoked and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q46. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q47. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q48. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q49. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variabel and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q49a. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q50. This answer will be used to determine years of exposure to hard liquor. A frequency distribution will be calculated.

Q51. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding high, medium, and low levels of consumption and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q52. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years drunk and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q53. This question is to aid the participant in answering Q54. A frequency distribution will be calculated.

Q54. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years drunk and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q55. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q56. This answer will be used to determine years of exposure to beer (i.e., drinking history). A frequency distribution will be calculated.

Q57. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding high, medium, and low levels of consumption and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q58. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years drunk and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q60. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years smoked and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q61. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q118, and Q119 to Q140.

Q61a. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the presence or absence of this variable and the prevalence of a morbid condition, listed in Q67 to Q 118, and Q119 to Q140.

Q62. This answer will be used to determine years of exposure to wine (i.e., drinking history). A frequency distribution will be calculated.

Q63. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding high, medium, and low levels of consumption and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q64. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years drunk and the prevalence of a morbid condition listed inQ67 to Q118, and Q119 to Q140.

Q65. This question is to aid the participant in answering Q66. A frequency distribution will be calculated.

Q66. This answer will be used to establish a frequency count. Risk ratios will be calculated regarding the number of years drunk and the prevalence of a morbid condition listed in Q67 to Q118, and Q119 to Q140.

Q67 to Q118. A frequency distribution will be compiled for each disease by the number of:
- a) Fishermen who have the disease
- b) Wives who have the disease
- c) Husband and wives how have the disease
- d) Children per family who have the disease
- e) Fishermen and one or more children who have the disease
- f) Wife and one or more children who have the disease
- g) Husband, wife, and one or more children who have the disease

Risk ratios of disease prevalence versus (Q18, Q19, Q20, Q21, Q22, Q23, Q24, Q25, Q26, Q27, Q28, Q28a, Q34, Q34a, Q40, Q40a, Q49, Q49a, Q55, Q55a, Q61, Q61a) will be calculated.

( )[1] these questions will hereafter be refered to as set "A"

Risk ratios of disease prevalence versus (Q30, Q36, Q42, Q51, Q57, Q63, Q31, Q37, Q43, Q52, Q64, Q33, Q39, Q45, Q54, Q60, Q66)[2] will be calculated.

( )[2] these questions will hereafter be refered to as set "B"

All information provided for these questions will be added to the date file including validation--confirmation or denial.

Q119 to Q140. A frequency distribution will be compiled for each symptom by the number of:
- a) Participants who respond Yes
- b) Frequency of occurrence
- c) Length of symptoms
- d) Participants who consulted a Doctor

Risk ratios of symptom prevalence will be calculated against question sets "A" and "B".

All information provided for these questions will be added to the date file including validation--confirmation or denial.

Q141. A frequency distribution will be compiled for:
- a) Number of natural children
- b) Number of step or adopted children
- c) Number of miscarriages
- d) Number of stillbirths
- e) Number of livebirths
- f) Number of other (e.g., abortions)
- g) Number of male children
- h) Number of female children
- i) Live birth weights

Risk ratios for the frequency of the above events will be calculated against set "A" and "B".

All information provided for these questions will be added to the data file, including validation--confirmation or denial.

Q141a. A frequency distribution will be compiled for:
- a) Number of participants answering Yes
- b) Percent of deaths which are male
- c) Percent of deaths which are female
- d) Average number of deaths for those who answer "Yes"
- e) Duration of life
- f) Causes of death

Risk ratios for those participants who answered "Yes" to this question will be compared against those who answered "No" to this question for set "A" and "B".

All information provided for these questions will be added to the data file, including validation--confirmation or denial.

Q142. A frequency distribution will be compiled for:
- a) Number of participants answering Yes
- b) Number of defects listed among those who answer Yes
- c) Type of defect in self
- d) Type of defect in sons, and percent living
- e) Type of defect in daughters, and percent living

Risk ratios for the frequency of the above events will be calculated against sets "A" and "B".

Q143. A frequency distribution will be calculated for the number of women using birth control methods.

Q144. The percent of women using each method will be determined.

Q145. A frequency distribution of age at initiation of birth control use will be calculated.

Q146. The frequency distribution of age at menarche will be calculated.

Q147. A frequency distribution will be calculated:
- a) For the entire cohort
- b) By stratification for Q19, Q22, Q25, and Q26
- c) By stratification for set A and B questions if sufficient numbers of participants respond to this question.

Q148. A percentage rating of natural versus surgical cessation of menstruation will be calculated. A frequency distribution will be calculated from validation reports regarding types of surgery.

Q149. A frequency distribution will be calculated:
- a) For the entire cohort
- b) By stratification for Q19, Q22, Q25, and Q26
- c) By stratification for set A and B questions if sufficient numbers of participants respond to this question.

Q150. A frequency distribution will be calculated:
- a) For the entire cohort
- b) By stratification for Q19, Q22, Q25, and Q26
- c) By stratification for set A and B questions if sufficient numbers of participants respond to this question.

Q151. A frequency distribution will be calculated:
  a) For the entire cohort
  b) By stratification for Q19, Q22, Q25, and Q26
  c) By stratification for set A and B questions if sufficient numbers of participants respond to this question

Q152. A frequency distribution will be calculated:
  a) For the entire cohort
  b) By stratification for Q19, Q22, Q25, and Q26
  c) By stratification for set A and B questions if sufficient numbers of participants respond to this question

Q153. A frequency count will be computed.

Q154. A frequency count will be computed.

APPENDIX VI

Progress Reports

1. October 16, 1978 - June 15, 1979
2. April 4, 1980 (Preliminary Report)

Assessment of Potential Health Risks Associated with Organic Contaminants

Feasibility Study - Great Lakes Basin

Progress Report

October 16, 1978 - June 15, 1979

Leonard M. Schuman, M.D.

Conrad P. Straub, Ph.D.

Principal Investigators

1. Introduction

In this progress report we summarize the activities undertaken by the Divisions of Epidemiology and Environmental Health, School of Public Health, University of Minnesota, Minneapolis, Minnesota, under Contract/Grant No. EPA/R806282-01-0, during the period October 16, 1978 through June 15, 1979.

During this period 12 students were employed to gather and assist in the evaluation of information pertinent to the study. These included five graduate students from the Division of Epidemiology under a young physician acting as project coordinator, and seven graduate students from the Division of Environmental Health with a scientist acting as project coordinator.

Throughout the study period, close liaison has been maintained between the two study groups with frequent meetings between the two project coordinators, between the two project coordinators and the principal investigators, and between the principal investigators and the total staff involved in the study.

This progress report consists of the following sections: 1) a report summarizing the findings of the epidemiological study group, 2) a summary report of the findings of the environmental study group, and 3) a series of questions which will be the basis for the continuation of the present study during year two.

References have not been included with this summary statement, but will be properly documented in preparation of the overall project report.

Specific directions to be taken during year two will also be defined.

2. Epidemiologic Studies

A literature review was undertaken to identify epidemiologic studies of the effects of organic pollutants on human health. The two clases of organic pollutants of special interest were halogenated and polycyclic aromatic hydrocarbons. Studies of primary interest are those which associate chronic disease effects (morbidity and mortality) with exposure to organic pollutants and include mutagenic, teratogenic, and/or carcinogenic effects. Other than the reported Yusho incident involving exposure to polychlorinated-biphenyls (PCBs) in Japan, and the Michigan and Indiana studies, few epidemiologic studies associating PCB exposure to human disease have been reported. To broaden the approach of the possible effects of PCB and other organic pollutants on human health, reported results of animal studies were evaluated to provide clues for hypothesis building of effects on man. Much support could be found in the literature on the mutagenic, carcinogenic, and teratogenic effects of organic pollutants on animals. One obvious problem is the translation of these results to human exposure experience.

With the virtual nonexistence of human epidemiologic studies in this area, our epidemiology group explored sources which could provide basic data on general and cause specific mortality; infant, neonatal, and perinatal mortality; fertility; congenital malformation, etc., for the development of needed studies in this field.

State health departments contacted were Minnesota, Wisconsin, Michigan, Ohio, Indiana, and Illinois. From these states, rates were obtained for infant, neonatal, and fetal deaths. These rates were inconclusive because of lack of adjustment for maternal age. From some states, congenital anomaly rates for live births were obtained but not for all years of interest. It must be kept in mind that such rates are grossly deficient because of under-reporting, even of those anomalies detectable at birth, and because of the difficulty of ascertaining many anomalies at birth. Site specific cancer rates by county were available from Michigan and Wisconsin; other states reported only cancer deaths or reported deaths collectively by system, i.e., respiratory system, gastrointestinal system, urinary system, etc. Site specific rates could probably be accessed by a review of death certificates. This is planned.

The National Center for Health Statistics lists cancer deaths by system but not by site. Only raw numbers were available. Rates were calculated using populations denominators from the Census Bureau. There were no age, race, or sex breakdowns.

County rates were desired to compare rates for lake-bordering as opposed to non-lake bordering counties. Use of date currently available for this comparison presents several problems including lack of adjustment for urban/rural differences, different sources of water supply, differences in length of residence, dietary habits, etc.

From the National Cancer Institute, twenty year (1950-1969) summaries were obtained of site-specific cancer mortality by county. These data were age-adjusted using as a standard the entire 1960 U.S. population. The data also identified white and non-white rates. Because the specific year data were not available, it is not possible to examine trends of mortality over time. For such data, we are planning to contact the National Cancer Institute and the National Center for Health Statistics to ascertain sex, age, and race-specific data by county and year, and the cost thereof.

A preliminary examination of the twenty-year data from the National Cancer Institute indicates a possible excess of stomach, esophageal, and other gastro-intestinal cancers in the lake-bordering counties as compared to non-lake bordering counties. However, because of urban/rural differences mentioned before, and other confounding factors, additional data are needed before conclusions may be drawn.

3. Environmental Health Aspects

Much of the available literature was reviewed, particularly that concerned with polychlorinated biphenyl (PCB) concentrations in air, in water and wastewater, in sediments and soils, and in the aquatic environment; with PBC intake by fresh water and marine organisms including fish; with the degradation of PCBs in the various environments; and with the effects of exposure on animals and humans. A general summary of this literature review follows.

PCB is a ubiquitous contaminant and is encountered in all environmental media. Some of the isomers have been identified in animal and human tissues. The mechanisms of transport have been indicated and do vary with the region studied. In the Great Lakes area, transport by air (rainfall and/or dry deposition) is the primary source of these materials, whereas in other locations direct discharge from industrial or other sources may be the major contributor. Because these substances are generally insoluble in water they adsorb on to particulates and eventually deposit on the bottom of lakes or other bodies of water as sediment or deposit directly on the soil. Generally, concentrations in water are very low, in many instances at or just above detectable levels. High concentrations are encountered in sediments and extensive biomagnification occurs through the aquatic food chain. Volatilization and biodegradation of the less chlorinated PCBs have reduced these levels in the sediments and have resulted in higher concentrations of these in the air and in air particulates. As a result, the more heavily chlorinated compounds are retained in the sediments, taken up by microorganisms and retained in lipids for long periods of time. They are not readily degraded nor metabolized.

Differences in results have been reported by many investigators and these differences will have to be reconciled. In addition, there are marked differences in uptake among various species of organisms exposed, and there are differences in response between so-called "pure" PCBs and those encountered in the environment.

In recent years attempts have been made to reduce the discharge of PCBs from controlled sources, but these procedures have not reduced levels in the Great Lakes or other bodies of water. These water bodies have become sinks for the deposition of large amounts of these substances with their retention in sediments. As a result, with minor degradation, they will serve as sources for the long-term, continued contamination of organisms associated with these environments. Attempts must be made to identify these sources, point or non-point, and to control them at their sites of production. Control measures are available for the destruction and degradation of some of these isomers. In other instances, more degradable isomers can be substituted for those currently used.

For the evaluation of possible health effects of exposure to PCB, we have the results of the Japanese Yusho exposure incident studies, and information on the effects of industrial exposure to PCBs during production and use to draw upon.

Questions have been raised as to whether the effects observed are due to PCB itself or to the presence of certain impurities associated with these materials. One impurity identified in many of the PCB isomers in commercial use is polychlorodibenzofuran, which is reported to be 10^4 to 10^6 times more toxic than PCB. The levels of these impurities must be determined, particularly since the major route of exposure, other than occupational exposure, appears to be related to the consumption of fish taken from the

Great Lakes or other contaminated bodies of water. Of significance, is whether ingestion of the mixtures of PCB isomers present in fish tissue can induce health effects directly, as a result of synergistic responses due to mixtures of isomers, or related to the presence of impurities, such as the chlorinated dibenzofurans, or other degradation products.

4. Questions Identified as a Result of Our Studies

From the studies carried out, numerous questions have arisen, some of which we hope to address during the coming year. These questions are identified below. In the epidemiology area the questions include:

1. Methods of accessing data not directly available from existing sources:
    a. county age-, sex-, and race- adjusted site-specific cancer death rates
    b. county maternal age-, race- adjusted infant, neonatal, and fetal death rates
    c. county malformation rates
    d. county fertility rates
2. Methodological problems of ascertaining trends in:
    a. cancer mortality
    b. infant, neonatal, and fetal mortality
    c. malformation morbidity
    d. fertility morbidity
3. Ascertainment of the appropriateness of existing methodology for teratogenic, mutagenic, and carcinogenic relationships to our study
4. Proper selection of high and low exposure contrast communities for retrospective studies
5. Possibility of doing rigourous, single community prospective studies
6. Appropriateness and feasibility of using bacterial and/or animal models to ascertain carcinogenic, mutagenic, and teratogenic effects

of the organic pollutants in lake water, in food chains, and in air at specific sites, i.e., in an individual community

In the environmental health area the questions that have arisen include:

1. Significance of the polychlorodibenzofuran impurities vis a vis effects currently attributable to various PCB isomers
2. Levels of exposure to occupational workers having contact with PCBs, its various isomers, or its derivatives, and health effects attributable to these exposures
3. Relevance of occupational exposures of the workers to exposure of his family
4. Determination of the sources responsible for total exposure to populations from environmental sources, their identity, and significance as exposure pathways
5. Identification of specific methodologies that can be used to reduce and/or control of the levels of PCB released to the environment
6. Evaluation of the methodologies used to collect samples, their effectiveness for providing information on actual environmental levels, and possible development of standardized procedures
7. Crititcal examination of reported data from a statistical point of view to assess the value of the findings reported
8. Determination of whether chronic toxicity is related to the metabolism of PCB and its intermediates or to the highly chlorinated stored PCBs
9. Study of the individual congeners, both those metabolized and those stored by man, is urgent because of their demonstrated carcinogenic potential
10. Evaluation of the long-term effect of release of PCBs from stored bottom sediment on the biota of these aquatic systems

It is hoped that some of these questions can be addressed during year two of the project to identify methodologies that will permit, if possible, a feasibility study, to relate environmental exposure levels to human effects.

Preliminary Report of Epidemiological and Environmental Data

Contract #EPA/R806282

Assessment of Potential Health Risks Associated with Organic Contaminants in the Great Lakes Basin

Feasibility Study

University of Minnesota
Division of Epidemiology
Division of Environmental Health

April 4, 1980

1. Summary

Several geographic areas in the Great Lakes Basin were selected and matched to existing vital statistics data. These areas were identified by reported point-source discharge violations of individual state effluent requirements by industries and municipal wastewater treatment plants. Point sources are associated with local areas of environmental contamination; however, the degree of environmental contamination (as measured by water pollution parameters) cannot predict the rates and routes of human exposure and ultimate health effects. Furthermore, current environmental data may not be completely indicative of past environmental conditions in a local area. However, current data may be viewed as a rough approximation of past conditions in situations where persistent contaminants have been discharged to the environment (PCBs and like organic compounds). Hence, the use of current environmental data (1970 - 1979) to characterize the previous 20 year period must be looked upon with great caution, particularly when comparing it with 20 year (1950-1969) cancer mortality rates.

The use of point source dischargers of potentially toxic materials as indicators of environmental contamination cannot entirely account for differences in the cancer, fetal, neonatal, and infant mortality rates observed between lake and non-lake counties. These differences may be associated with differences in the smoking, drinking, and dietary habits of the populations being studied, their ethnic and socio-economic status, and the degree of industrialization of the geographic areas in which they live and/or work. For example, differences in stomach cancer mortality rates may be associated with certain ethnic groups rather than environmental pollutants. Similarly, lung cancer differences may be far more associated with cigarette consumption patterns than with exposure to environmental pollutants. Furthermore, the state vital statistics data are not adjusted for age, sex, and race differences in each county within each state. Therefore, some observed differences between lake and non-lake counties may be attributed to differences in the age, sex, or race composition of the counties.

It is apparent that the inadequacies of a county's epidemiological and environmental data have made evaluation of the association between mortality rates and environmental contaminant levels difficult. However, valuable experience has been gained during this initial accumulation and evaluation of existing data, particularly in identifying specific areas to be addressed in future efforts and in the need to assess confounding and interacting risk factors.

II. Morbidity/Mortality Data Collection and Analysis

An important initial step in determining the potential health effects of certain ubiquitous organic pollutants in the Great Lakes Basin was to investigate the availability of existing morbidity and mortality data from various data sources. It was apparent from the literature that PCBs (and like organic compounds) are potential carcinogenic and teratogenic agents. Thus, the investigation focused on site-specific cancer mortality rates, fetal, neonatal, and infant death rates, and congenital anomaly rates (which can be expressed as either death rates or as a percentage of live births).

Since these types of organic pollutants are quite persistent in the environment and have been used for over thirty years by various industries, data back to 1950 were sought. However, the voluminous amount of data involved over this thirty year period for eight states (Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York) warranted a limited examination of these data. Specifically, state vital statistics were thoroughly examined for Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio for every fifth year from 1950 plus the most current year (usually 1977).

The hypothesis was posed that areas adjacent to the Great Lakes have a greater exposure potential to these pollutants than those areas more distant from the Lakes based on the following assumptions:

1. Most lake bordering communities have increased industrial activity compared to most non-lake bordering communities.
2. Individuals living in these adjacent communities are more likely to be occupationally exposed to those pollutants being discharged into the air and the Lakes.

3. Close proximity to the Lakes would lead to greater exposure via ambient air, soils, and water.
4. Fishermen living in these lake-adjacent communities are more likely to fish these lakes and may have higher exposures due to consumption of their catch.

Based on this hypothesis, it was decided to examine (for camparative purposes) the morbidity/mortality data for lake and non-lake communities. Since the smallest geographical area for which data are readily available in the country, the investigations centered on gathering data by county and comparing lake counties to non-lake counties within each state.

The first source investigated was the vital statistics record for each individual state. Rates by county for site-specific cancer mortality; fetal, neonatal, and infant mortality; and congenital anomalies were requested from each State vital statistics office for the following years: 1950, 1955, 1960, 1965, 1970, 1975, and 1977. The data available are indicated below:

1. All states have data available by county on fetal, neonatal, and infant death rates. However, in most cases, these are not race or sex specific.
2. All states have rates for deaths due to congenital anomalies by county but these are not age, sex, or race specific. Data on congenital anomalies as a percent of live births by county

are available from selected states for selected years. These data, again, are not sex or race specific.

3. Most states do not have site-specific cancer mortality rates by county. For the states that do, the data are generally not age-race- or sex-specific.

(For a more detailed account of the data available from each state, refer to the cover page which precedes each individual state's vital statistics).

The yearly publications of the National Center for Health Statistics (NCHS) were also examined for relevant information. These data are comparable to the data obtained from each individual state. The NCHS does publish fetal, neonatal, and infant death rates by county but they are not race-or sex-specific. They also publish death rates for congenital anomalies by county. Site-specific cancer mortality data are not published by county by the NCHS.

The best source of cancer mortality data by county was found in the National Cancer Institute publication entitled: "U.S. Cancer Mortality: 1950 - 1969". This publication contains 20-year summary rates of site-specific cancer mortality by county. These rates are sex-and race-specific and age-adjusted. The drawbacks of these data are: 1) since the rates are a 20-year summary, time trends cannot be examined and 2) there are no similar data that are more recent.

Lake bordering and non-lake bordering counties were compared using the following information: 1) site-specific cancer mortality rates from the NCI 20-year data and from state vital statistics and 2) fetal, neonatal, and infant death ratios from state vital statistics data. The fertility and congenital malformation rates were also compared when these types of data were available from the state's vital statistics.

Mean values for all cancer death rates and fetal, neonatal, and infant death rates of lake-bordering counties were compared to the respective mean values of non-lake bordering counties within each state. Those parameters having higher mean values in lake-bordering counties than non-lake bordering counties are noted for each state. (see cover sheet attached to state data). No tests of statistical significance were calculated for these observed differences.

Maps were prepared for each state depicting the counties with the highest and lowest rates (within that particular state) for selected parameters. The parameters used included the NCI 20-year cancer mortality data for cancers of the stomach, lung, esophagus and all neoplasms. These particular cancer sites were chosen because their mean mortality rates appeared to be consistently higher for lake-bordering counties than for non-lake bordering counties in all states. Additional parameters include the fetal and neonatal death rates for the years 1970, 1975, 1977, percent of live births with congenital anomalies for the years 1970, 1975, 1977, (only available for Wisconsin, Michigan, and Minnesota) and fertility rates for the years 1960, 1970 (only available for Ohio, Wisconsin, and Minnesota). The means and standard deviations were calculated for all available parameters within each state. Those counties with rates significantly (± 2S.D.) different from the state mean are identified with an asterisk on the maps.

III. Selection of Study Populations Based upon Environmental Factors

Upon completion of an extensive scientific literature review of PCBs (and like organic compounds), it was apparent that these substances are ubiquitous environmental contaminants. Much of the data, however, clearly demonstrate that there are regional differences and that the effects are consistent across all media (e.g., water, sediments, fish, and birds), generally showing greater concentrations in highly developed areas and areas of industrial activity. Thus, it was not surprising that the Great Lakes Basin area (the most industrialized area in the United States), based on the literature review, appeared to be experiencing a higher degree of environmental contamination with these potentially toxic materials as compared to other regions of the country.

To elaborate further on the degree of environmental contamination the Great Lakes Basin has sustained from PCBs (and like organic compounds), it was quite obvious that our data base had to be expanded to include specific quantitative and qualitative data and information of specific areas within the Basin. Thus, various state, federal, and international environmental agencies (with some type of jurisdiction in the Basin) were consulted concerning the existence and availability of specific environmental data. Each agency was requested to provide qualitative and quantitative data on organic contaminants which the agency had identified in point sources (waste water discharges), atmospheric sources, wastewater sludges, runoff, sediments, ambient water, drinking water, landfill leachates and vent gases, and fish caught within the Basin.

The agencies and organizations contacted responded favorably to the request but little meaningful data were actually received. Generally it was apparent that considerable environmental data do exist but are not readily available for review or compilation. (Most states store such data in vertical files.) However, a series of documents were received from the International Joint Commission (IJC) which were compilations of data solicited from various Canadian and American jurisdictions within the Great Lakes Basin (1,2,3,4). It should be noted that the IJC documents include data that some state officials have identified as also being available from their agencies; therefore, there may be duplications of data when multiple data sources are used.

The IJC documents were thoroughly reviewed and it was decided that the data contained therein could be used to select (on the basis of various criteria) specific areas or communities within the Basin that may be experiencing a high degree of PCB (or like organic compound) contamination. It was then assumed that people living in these communities could have potentially higher degrees of exposure to these contaminants in their immediate environment. Thus, this attempt permitted an initial approach at integrating environmental data which identified groups receiving potentially higher exposures with morbidity/mortality data. A number of approaches were taken and will be discussed.

The focus of this investigation is to identify study populations which can be used to evaluate the potential health risks associated with organic contaminants in the environment of the Great Lakes Basin. Using data from the International Joint Commission Great Lakes Water Quality Board concerning designated "problem areas", high PCB concentrations in Great Lakes sediments, and point source dischargers, several communities were selected for further environmental and epidemiological characterization.

Table 1 lists "problem areas" based on an evaluation of the data contained in the "Great Lakes Water Quality 1978 Report". These "problem areas" were selected because of reported violations of water quality standard with respect to organics (i.e., phenols, chlorobenzenes) and/or PCBs. Point sources were implicated as the cause of these problem areas but were not recorded in this table.

Other communities were selected as potential sites for environmental and epidemiological evaluation using existing sediment data from the "Status Report on Organic and Heavy Metal Contaminants in the Lakes Erie, Michigan, Huron, and Superior Basins". (2,3) Table 2 lists committees adjacent to the Great Lakes where PCB bottom sediment concentrations $\geq$mg/kg have been identified. These high levels are thought to be associated with point source dischargers but were not so identified in this report.

TABLE 1

Following an examination of the data obtained in the "Great Lakes Water Quality 1978 Annual Report"[I] the following geographical areas were identified as possible sites for future epidemiological and environmental evaluation. These identifications were based upon violations of objectives or standards with respect to organics (i.e., Phenol) and/or PCBs. Both industries and wastewater treatment plants are identified as being potential sources for these discharged substances. The following table lists the problem areas and the associated lake.

LAKE	PROBLEM AREA
Superior	Thunder Bay, Jackfish Bay **
Huron	St. Marys River, Spanish River **
Michigan	Waukegan Harbor, Indiana Harbor
Erie and St. Clair	St. Clair River, Detroit River, Cleveland area,* Black River, Rouge River, and Ecorse River
Ontario	Buffalo River, Upper Niagra River, Lower Niagara River, Mississauga - Clarkson area, ** Grass River

*Areas where water quality objectives have not been achieved because remedial programs are not yet completed.

**Canadian jurisdiction

Table 2

List of communities adjacent to the Great Lakes where PCB* concentrations equal to or greater than 1 mg/kg have been identified in the bottom sediments.

Lake Basin	Location	PCB, mg/kg Level
Michigan	Waukegan, IL	0.1 to 16,400
	Indiana Harbor, IN	.04 to 25.7
	Fox River, WI	0.67 to 11.56
	Escanaba, MI	1.6
	Manistique, MI	10.2, 3.2, 25.5+
	Milwaukee, WI	6.4
Erie	Cuyahoga River, OH	0.29 to 2.20
	Ashtabula, OH	<0.1 to 1.10
	Fairport, OH	0.7 to 1.10
	Cleveland, OH	<0.01 to 2.30
Huron	No data presented above 1 mg/kg.	
Superior	No data presented above 1 mg/kg.	
Ontario	Hamilton, ONT.	1.3 to 10
	United States locations were below 1 mg/kg	

+ Combined Aroclor 1254 + 1242

* Total PCB

Point source dischargers can account for higher local levels of contaminants as compared to those levels found in the surrounding environment. These sources may influence the exposure potential and effect the health status of surrounding communities. Point sources include combined storm sewers, wastewater treatment plants, industries, and power plants. The data contained in an "Inventory of Major Municipal and Industrial Point Source Dischargers in the Great Lakes Basin" were used to identify sources of potentially hazardous organic compounds in the Great Lakes Basin,(4) and select and compare several geographic areas or possible sites for a cooperative epidemiologic and environmental study. The areas selected are identified based on the following criteria:

1. communities in which at least one industry measured organics (i.e., phenols) prior to discharge and complied with state effluent requirements, and in which the wastewater treatment plants complied with state effluent requirements [on the basis of phosphorus (P), biological oxygen demand (BOD), and suspended solids (SS)]. (Tbl 3)
2. communities in which at least one industry measured organics (i.e., phenols) prior to discharge and failed to comply with state effluent requirements, and in which a wastewater treatment plant failed to comply with state effluent requirements (on the basis of P, BOD, and SS). Table 4.
3. communities in which at least one industry measured organics (i.e., phenols) prior to discharge and failed to comply with state effluent requirements, and in which the wastewater treatment plants complied with state effluent requirements (on the basis of P, BOD, and SS). Table 5.

4. communities in which at least one industry measured organics (i.e., phenols) prior to discharge and complied with state effluent requirements, and in which a wastewater treatment plant failed to comply with state effluent requirements (on the basis of P, BOD, and SS). Table 6.

TABLE 3

Communities in which at least one industry measured organics (i.e., phenols) prior to discharge and complied with state effluent requirements, and in which the wastewater treatment plants complied with state effluent requirements (on the basis of P, BOD, and/or SS).

County	City	Cancer Mortality Rates*
Allen	Fort Wayne, Ind.	-
Porter	Chesterton, Ind.	-
Gratiot	Alma, Mich.	-
Saginaw	Saginaw, Mich.	-
St. Clair	Port Huron, Mich.	-
Erie	Lackawanna, NY	high esophagus (6.7), stomach (18.8), lung (47.8) all neoplasms (207.0)
Niagara	N. Tonawanda, NY	high esophagus (5.5)
St. Lawrence	Messena, NY	-
St. Lawrence	Ogdensburg, NY	-

* Identified as being high from preliminary reported information for a a particular county in a specific state.

()Indicates mortality rates (deaths/100,000) within a specific county for respective states.

TABLE 4

Communities in which at least one industry measured organics (i.e. phenols) prior to discharge and failed to comply with state effluent requirements, and in which a wastewater treatment failed to comply with state effluent requirements (on the basis of P, BOD, and/or SS).

County	City	Cancer Mortality Rates*
Lake	E. Chicago, Ind.	high esophagus (5.4), stomach (21.9), lung (47.9), all neoplasms (198.4)
Kalamazoo	Kalamazoo, Mich.	-
Ottawa	Holland, Mich.	-
Wayne	Wyandotte, Mich.	high esophagus (6.4), lung (47.3), all neoplasms (209.2)
Allen	Lima, OH	-
Cuyahoga	Cleveland, OH	high esophagus (7.5), stomach (20.7) lung (45.8), all neoplasms (211.9)
Lorain	Lorain, OH	high esophagus (5.6), stomach (20.2), all neoplasms (189.7)

*See Table 1

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TABLE 5

Communities in which at least one industry measured organics (i.e., phenols) prior to discharge and failed to comply with State effluent requirements and in which the wastewater treatment plants complied with state effluent requirements (on the basis of P, BOD, and/or SS).

County	City	Cancer Mortality Rate*
Niagara	Lockport, NY	high esophagus (5.5)

*See Table 1

TABLE 6

Communities in which at least one industry measured organics (i.e., phenols) prior to discharge and complied with State effluent requirements, and in which a wastewater treatment plant failed to comply with State effluent requirements (on the basis of P, BOD and/or SS).

County	City	Cancer Mortality Rate*
Lake	E. Chicago, IL	high esophagus (5.4), stomach (21.9) lung (47.9), all neoplasms (198.4)
Lake	Gary, IN	high esophagus (5.4), stomach (21.9), lung (47.9) all neoplasms (198.4).
Alpena	Alpena, MI	-
Bay	Bay City, MI	high lung (43.9), all neoplasms (196.4)
Genesse	Flint, MI	-
Ottawa	Holland, MI	-
Wayne	Detroit, MI	high esophagus (6.4), lung (47.3), all neoplasms (209.2)
Wayne	Trenton, MI**	high esophagus (6.4), lung (47.3), all neoplasms (209.2)
Erie	Tonawanda, NY**	high esophagus (6.7), stomach (18.8), lung (47.9), all neoplasms (207.0)
Monroe	Rochester, NY	-
Niagara	Niagara Falls, NY	high esophagus (5.5) high stomach (21.7)
Cuyahoga	Cleveland, OH**	high esophagus (7.5), lung (45.8) stomach (20.7), all neoplasms (211.9)
Lucas	Toledo, OH	high esophagus (5.7), lung (45.6), all neoplasms (196.4)

*See Table 1

**Areas where there are 2 or more WTPS, some in compliance others not.

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Following preparation of these city lists, the state maps indicating high and low county cancer mortality rates were used to determine if these cities were located in counties with unusually high cancer mortality rates. Blanks for cancer mortality rates do not imply an absence of cancer, but that the rate for the county containing the specific community was not among the five highest in the state for any of the cancer sites of esophagus, stomach, and lung and/or all neoplasms. These results indicate a possible association between point sources of hazardous materials, their compliance status with respect to state effluent requirements, and cancer mortality rates.

It was hypothesized that those counties with point-source dischargers of hazardous materials in compliance with state effluent requirements may have different cancer rates than those counties with point source dischargers of hazardous materials failing to comply with state effluent requirement. A two tailed T-test was used to evaluate the level of significance for differences observed between cancer mortality rates in counties containing cities listed in Table 3 (i.e., communities in which at least one industry measured organics prior to discharge and complied with state effluent requirements and in which the wastewater treatment plants complied with state effluent requirements) and counties containing cities listed in Table 4 (i.e., communities in which at least one industry measured organic prior to discharge and failed to comply with state effluent requirements and in which a wastewater treatment plant failed to comply with state effluent requirements).

The mean cancer rates for counties listed in Table 3 (total compliance) were compared to the mean cancer rates for counties listed in Table 4 (total non-compliance). The cancer mortality rates for counties containing the cities listed in Table 4 were significantly greater than the cancer rates in counties containing cities listed in Table 3 at the p = 0.05 level for the following sites:

white males	stomach (0.012)*
	kidney (0.029)
non-white males	nose, auxiliary sinuses, etc. (0.011)

and at the p = 0.10 level for the following sites:

white males	nasopharynx	(0.080)
	pancreas	(0.075)
	all other	(0.092)
white females	stomach	(0.097)
	pancreas	(0.098)
non-white males	stomach	(0.100)

However, the cancer mortality rates for counties containing the cities listed in Table 3 (total compliance) were significantly greater than the cancer rates in counties containing cities listed in Table 4 (total non-compliance) at the p = 0.05 level for the following sites:

white males	nose, auziliary sinuses, etc. (0.041)
white females	nose, auziliary sinuses, etc. (0.032)

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*() Indicates p value

non-white males	salivary	(0.049)
	malanoma	(0.032)
	lymphoma, etc.	(0.030)
	all other	(0.013)

and at the p = 0.10 level for the following sites:

non-white males	biliary and liver	(0.059)
non-white females	salivary	(0.099)
	biliary and liver	(0.099)
	other skin	(0.059)

Bibliography

1. "Great Lakes Water Quality 1978 Annual Report." International Joint Commission (IJC), Great Lakes Water Quality Board, July 1979.

2. "Great Lakes Water Quality - Appendix E: Status Report on Organic and Heavy Metal Contaminants in the Lakes Erie, Michigan, Huron, and Superior Basins." IJC, Great Lakes Water Quality Board, July 1973.

3. "Great Lakes Water Quality - Appendix E: Status Report on the Persistent Toxic Pollutants in the Lake Ontario Basin." IJC, Great Lakes Water Quality Board, December 1976.

4. "Inventory of Major Municipal and Industrial Point Source Dischargers in the Great Lakes Basin." IJC, Great Lakes Water Quality Board, July 1978.

IV. Intense Environmental Characterization: Pilot Study to Determine the Availability of Existing Environmental Data

It was apparent that the preliminary selection of potential study counties was based on very broad and non-specific data. However, these counties were selected on the premise that detailed quantitative and qualitative data on specific contaminant concentrations in various environmental strata could be obtained and evaluated. Thus, a complete environmental characterization could be developed for each individual lake county, with the intent of ultimately determining morbidity and mortality rates and potential routes of exposure of the indigenous populations to specific contaminants. A similar approach could be taken for counties chosen as controls (i.e., non-lake counties).

In order to accomplish these objectives, a pilot study to determine the availability of existing data and to evaluate the usefulness of these data in assessing possible exposure levels was established. Two counties were selected within the same state to determine the kinds of data available locally. Additional data were obtained by contacting State and Federal agencies who were responsible for environmental monitoring in these counties. These data would provide insight on some aspects of the prevailing environmental conditions. Furthermore, deficiencies in the available data could be identified and the need for additional monitoring could be evaluated.

The state environmental agency was contacted first, to request access to their files, which contained environmental information for these counties. The following were requested: 1) surface water dischargers (wastewater): NPDES permits, effluent and sludge analysis for specific potentially toxic materials (PCBs), sludge handling and disposal practices, and sludge disposal sites; 2) public drinking water supplies: source (ground or surface), treatment provided, general water quality parameters, and specific analyses for potentially toxic materials (PCBs, chlorinated pesticides) of both the finished and raw water; 3) sanitary landfills: location, leachate analysis, types of materials disposed, and vent gas analysis; 4) ambient air: location of monitoring stations, specific parameters, and location of incinerators; 5) special environmental monitoring surveys for PCBs, pesticides, etc.: lake and river sediments, ambient water, fish flesh, and soil. Other agencies in the state were also contacted and relevant data were requested. These include: flesh analysis of fish caught within the waters of each county, and market-basket analysis of food products consumed.

The USEPA, Revion V office was contacted for data pertaining to environmental concentrations of organic contaminants in these counties available through their computer information service (STORET).

Studies conducted by NIOSH evaluating the health hazards associated with PCB usage in industry were requested to evaluate potential worker exposure in similar industries located in the study counties.

The following summary characterizes the types of data collected from these data sources.

1. State environmental agency data and information.

a. Agenny personnel have identified as suspect seven landfills in one county and two in the other as receiving PCBs (wastewater treatment sludges and industrial oils and solvents). The monitoring of leachates and aquifers beneath landfill sites will be initiated in 1980; very few specific results are available at this time.

b. 27 wastewater dischargers (i.e., industrial and municipal wastewater treatment plants - WTPs) in one county and four in the other were identified as potential sources of PCBs or other similar synthetic organic compounds.

Two large WTPs in one county reported detectable levels of specific synthetic organic compounds (PCB and DDT) and a phthalate ester in their effluents.

c. Public water supply information indicated that six areas in one county obtain drinking water from surface supplies. The remainder of the county population obtains drinking water from groundwater sources. In the other county drinking water is obtained exclusively from ground sources.

Pesticide levels in surface water supplies are available for one county. These date are pursuant to the provisions of the safe drinking water act. However, they are reported as meeting the requirements rather than reporting the actual concentrations found. No PCB data exist for groundwater supplies.

d. Surface water quality data are available for one county and included measurements for dieldrin, DDT (total), and PCBs in three locations (two rivers and an adjacent lake). Surface water quality data for pesticides or PCBs are not available for the other county

e. Two environmental surveys have been carried out in one of the counties. These included analyses of fish, ambient water, and sediments for PCBs and other synthetic organic compounds. No such surveys were performed in the other county.

f. Fish analyses in the one county included PCB, and chlorinated pesticides concentrations in lake trout and chinook salmon. No data were reported for the other county on PCBs or any other contaminants.

2. USEPA "STORET" computer information

a. Surface water quality data are available for both counties; these data do not include measurements for PCBs, pesticides or other organics. However, phenolic and oil and grease concentrations are measured at several monitoring stations in both counties.

b. Data on analysis of sediments are sparse. There are only two monitoring stations in one county, and four in the other. Results are available from analysis of only one sample collected at each monitoring station.

c. Analysis of fish collected in both counties were available. Data are not, however, consistent throughout the computer print-out. Critical variables not reported include: species, age, sex, weight, time of year tested, portion tested and fat content.

d. There is no information on PCB (or other synthetic levels since their industrial use, it may be possible to extrapolate these findings over a longer period of past exposure. Finally, when specific study counties are eventually selected the experience learned in this pilot study should provide a useful approach to the characterization of study county environmenta.

organic compounds) concentrations in air, landfill leachates or vent gases.

3. State Departments of Conservation and Public Health information.
    a. Both agencies have generated copious quantities of data pertaining to fish flesh analyses for PCBs, heavy metals, and chlorinated pesticides. A large variability exists, however, in the time of year samples, number per sample, and type of sample (i.e., whole, fillet, etc.). For one county data are available for yellow perch, lake trout, coho salmon, and bloaters. In the other county, only carp were surveyed consistently for PCBs and chlorinated pesticides.
4. Local health departments were contacted but their data were similar, if not identical, to data obtained from the state agencies.
5. Research data from universities in the vicinity of the counties were contacted. However, to date no data have been obtained from these sources.

The location of specific data sources are plotted on large-scale county maps. These are useful in locating dischargers of various contaminants and their potential for the contamination of fish, water, sediments, etc. and the location of possible sources of exposure to local population groups. It should be pointed out that these data, for the most part, covered concentrations measured and found in the last five to ten years. However, since these contaminants (PCBs and chlorinated organic pesticides) are highly persistent and have been in the environment at various